Chapter 3. Affected Environment

Introduction

This chapter provides an understanding of both the general environmental setting of the project area and a focused description of those resources that could be affected by the implementation of the FEIS alternatives. The Affected Environment is required (by the Council on Environmental Quality NEPA regulations, sec. 1502.15) to succinctly describe the environment of the areas likely to be affected by the alternatives under consideration, and focus efforts and attention on important issues.

The project area encompasses all of Point Reyes National Seashore (PRNS) and the northern lands of Golden Gate National Recreational Area (GGNRA) administered by PRNS.

Project Site Description

The project area is located in central California, in western Marin County, approximately 40 miles northwest of the City of San Francisco (see Figure 2). It is comprised of federal lands managed by the Point Reyes National Seashore, a unit of the National Park System, and is within 50 miles of the nine-county San Francisco Bay Area, the 5th largest metropolitan area in the United States.

Generally, the more developed regions of the bay area surround the bay itself, with smaller cities, towns, open space, and agricultural areas in an outer ring around the urban core. Forty-eight percent (159,044 acres) of the 332,800 acres in Marin County is held as parks, open space, and watershed (Marin County 2002). Thirty-six percent (119,808 acres) is in agricultural use. Developed lands constitute only 11% of the county while 5% of the county has future development potential.

While eastern Marin is heavily developed along the Highway 101 corridor, western Marin is primarily rural with scattered small, unincorporated towns that serve agriculture, local residents, and tourism. Roughly 90% of the quarter of a million residents of Marin County live in the eastern half of the County along the major transportation corridor, State Highway 101.

Regional Context and Surrounding Communities

The project area consists of 71,000 acres of the Point Reyes National Seashore and 19,265 acres of Golden Gate National Recreation Area, as well as 86 miles of shoreline on both the Pacific Ocean and Tomales Bay (see Figure 2). The Seashore includes beaches, coastal cliffs and headlands, marine terraces, coastal uplands, woodlands, and forests on the Point Reyes Peninsula.

PRNS is bounded to the north, west, and southwest by the Pacific Ocean and to the east by the residential communities of Inverness, Inverness Park, Point Reyes Station, Olema, and Dogtown (see Figure 2). The town of Bolinas is south of PRNS at the southern tip of the Peninsula. An estimated 3,800 permanent residents live in the towns and communities close to the project area from the tip of Tomales Bay in the north to Stinson Beach in the south (U.S. Census Bureau 2000). The census population figure does not count the many part-time residents of western Marin who maintain second homes in the project area.

Through a memorandum of agreement between the two national parks, PRNS manages the 19,265 acres of Bolinas Ridge for GGNRA (NPS 1988b) . Bolinas Ridge is a northwest/southeast trending ridge paralleling the Olema Creek valley and the San Andreas Fault zone. The northwest-facing slope of the

Ridge is primarily grassland and shrub with east facing slopes forested with Douglas fir and coast redwood.

A number of private inholdings exist within the Seashore, including 2,143 acres in Olema Valley, owned and managed by the Vedanta Society. East of the project area, land use is a mix of private residential and agricultural lands, publicly held watershed, and parks and open space. Adjacent to the park are areas managed by Audubon Canyon Ranch, Marin Municipal Water District, Tomales Bay and Samuel P. Taylor State Parks, and Marin County open space lands. Marine boundaries are shared with the Gulf of the Farallones and the Cordell Bank National Marine Sanctuaries, and Tomales Bay State Park. Some agricultural parcels are part of the Marin Agricultural Land Trust to which the owners have deeded development rights to protect rural agriculture from development pressures.

FIGURE 2: MAP OF THE PROJECT AREA

Park Management Zoning

PRNS and GGNRA share a general management plan (NPS 1980), which uses the following zoning designations to guide park management.

Project area lands fall under one of two management zones: Natural Resource Zones or Historic Resource Zones. The Natural Resource Zone covers pastoral lands, natural landscape areas, sensitive resources, designated wilderness, and marine reserves. Historic ranches, the Point Reyes lighthouse, and the lifesaving station are included in the Historic Resource Zone.

Natural Resource Zones

Pastoral Lands (northern Olema Valley and northern Point Reyes peninsula). Approximately 17,000 acres of PRNS have been retained in agricultural production supporting beef and dairy production. The Northern District of GGNRA contains an additional 10,500 acres leased for cattle grazing. Pastoral operations presently include seven dairy and ten beef cattle ranches. The general management plan (GMP) for the Seashore indicates that at a minimum, agricultural buildings and open grasslands would be retained in these areas, and where feasible, livestock grazing would continue within the limits of carefully monitored range capacities (NPS 1980, p. 18). The GMP also indicates that future resource management studies could substantially alter the configuration of this zone.

Natural Landscape Areas (southern Olema Valley and Bolinas Ridge, Limantour Road corridor and Limantour Beach, Tomales Bay shoreline north of the State Park, Bear Valley, recreational beaches, road corridors, and select trail corridors). Natural Landscape Areas contain important natural resources that are not within the designated wilderness of PRNS. The largest track is the southern half of the Bolinas Ridge, lands buffering Limantour Road and Limantour Beach, and the Marshall Beach area north of Tomales Bay State Park. GMP direction for these areas is that natural resources and processes remain as undisturbed as possible given a relatively high level of park use (NPS 1980, p. 18). The Olema Valley is managed to maintain the visual contrast between woodland and open grassland (NPS 1980, p. 96).

Special Protection Areas (Philip Burton Wilderness Area, Gulf of the Farallones National Marine Sanctuary, State of California Marine Reserves, shorelines, and riparian corridors). Special Protection Areas includes lands that have received legislative or special administrative recognition of exceptional natural qualities requiring strict protection measures. They include wilderness and areas of particularly sensitive natural resources.

Wilderness

The purpose of wilderness in the national parks includes the preservation of wilderness character and wilderness resources in an unimpaired condition, as well as for the purposes of recreational, scenic, scientific, educational, conservation, and historical use. Management includes the protection of the areas, the preservation of the wilderness character, and the gathering and dissemination of information regarding their use and enjoyment as wilderness.

The Wilderness Act requires that, except as necessary to meet the minimum requirements for the administration of a wilderness area, “there shall be no temporary roads, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, or no other form of mechanical transport, and no structure or installation” within the wilderness (16 U.S.C. 1131). As required by the Wilderness Act, actions necessary to prepare and execute resource enhancement projects must be examined to assure that they are necessary. If the park deems a project necessary, it is required to use the least intrusive methods

possible to carry out the needed actions. This "minimum requirement" process is designed to ensure the least disturbance and disruption of wilderness values and maximum protection of natural and cultural resources. At PRNS, the examination of minimum requirements is undertaken and documented by the interdisciplinary team reviewing projects for compliance to the National Environmental Policy Act. The procedure for determining the minimum requirement for each alternative is described in Appendix A (Wilderness Minimum Requirement Guide) and in the section Actions Common to All Alternatives.

The laws that established the Point Reyes Wilderness Area (90 Stat. 2515 and 90 Stat. 2692; 16 U.S.C.) mandated that it be managed "…without impairment of its natural values, in a manner which provides for such recreational, educational, historic preservation, interpretation, and scientific research opportunities as are consistent with, based upon, and supportive of the maximum protection, restoration, and preservation of the natural environment within the area."

The majority of the Wilderness is in the southern half of PRNS, from Mount Vision south to Palomarin, including Inverness Ridge. The wilderness supports primarily Douglas fir and mixed hardwood forests, riparian areas, coastal bluffs, and beaches. Elevations range from sea level to 1,407 at Mt. Wittenberg. While axis deer are currently not believed to inhabit wilderness areas in the study area, about one-third of the known fallow deer range (or about 8,000 acres) is inside wilderness boundaries.

More than half of PRNS is designated or proposed wilderness, and must be managed in conformance with the 1964 Wilderness Act, NPS *Management Policies* 2001 (Chapter 6), the Director's Order, and Reference Manual 41 for Wilderness Preservation and Management. As directed in NPS *Management Policies* 2001 (Section 6.3), natural resources management activities in wilderness areas:

- must conform to the basic purposes of wilderness,
- must apply the principle of non-degradation; each wilderness area's condition would be measured and assessed against its own unimpaired standard, and
- should seek to sustain the natural distribution, numbers, population composition, and interaction of indigenous species.

The NPS *Management Policies* 2001 also confirm that scientific activities in wilderness areas must use the "minimum requirement" concept, a process of identifying the least damaging tools or activities, to protect natural and cultural resources, and minimize any lasting impacts. Analysis of transitory effects upon wilderness values are focused on determining whether they are outweighed by the benefits to be derived for the long-term preservation of wilderness character.

Some lands at PRNS are particularly sensitive to human use or are especially valuable from an ecological or scientific point of view. Most of the areas are watercourses or bodies of water recognized for their importance in sustaining wildlife and vegetation. The GMP states that use and development in these areas would be either discouraged or mitigated sufficiently to avoid major levels of deterioration.

Other Significant Area Designations

Due to the interface of the Seashore with the Pacific Ocean and its importance to wildlife, the Seashore coordinates and cooperates with an increasing number of agencies and organizations including the National Marine Fisheries Service (NMFS), U.S. Geological Survey (USGS), Gulf of the Farallones National Marine Sanctuary, Golden Gate Biosphere Reserve members, U.S. Fish and Wildlife Service (USFWS), the Audubon Society, California Department of Parks and Recreation, Point Reyes Bird Observatory, Marine Mammal Center, and CDFG.

In 1988, UNESCO Man in the Biosphere program designated the Central California Coast Biosphere Reserve under the International Biosphere Program. The Central California Coast Biosphere Reserve includes the entire Seashore, the Golden Gate National Recreation Area, and other public lands in the region. In addition, the State of California designated three "Areas of Special Biological Significance" within the Seashore: Tomales Point, Point Reyes Headlands, and Double Point. These designations add to the need to maintain or return the Seashore to as natural state as possible.

Climate

Cool wet winters and warm dry summers, influenced by low-lying fog and strong sea breezes, characterize the coastal Mediterranean climate of the study area. The climate is unusual in that temperatures remain fairly consistent throughout the year. Temperatures rarely exceed 90° or drop below 40° F. Thick, rapidly moving fogbanks shift from offshore to on shore in a predictable pattern throughout the summer. The approach of the fogbank can cause temperatures to change rapidly dependent on proximity to the ocean and elevation. The ocean temperature averages 55° year-round. The cold ocean waters and low fog mitigate the summer heat common in eastern Marin County where temperatures are often in the 90s. Typically, as one moves away from the coast the climate usually becomes warmer and drier, especially in the summer.

On average, ninety-one percent of the annual precipitation falls between October and March. Precipitation at the Lighthouse or near the Pacific shore may be less than half of that recorded on Inverness Ridge, Olema, or in Inverness. The 1,000 to 1,500-foot Inverness Ridge provides an orographic effect – wringing the clouds of their moisture. Annual rainfall averages range from 18 inches at the Point Reyes Lighthouse to 40 inches at Inverness Ridge and Bear Valley (Evens 1993)

The summer months are prone to fog as the vacuum created by warming air and low pressure in the Central Valley draws the moist marine air inland. Fog drip is most prevalent at the higher elevations where wind blows the saturated air over the ridgeline and into the Olema Valley. The needles of Douglas fir and Bishop pine trees capture moisture, which accumulates and drops to the soil below. Research shows that fog drip is proportional to the surface area of the individual trees. In some areas of PRNS as much as 20 inches of precipitation can be extracted annually from the fog by individual trees, with that water supporting the lush understory and growth of the woody vegetation. Fog drip augments the groundwater supply, reducing stress on the aquifers, and possibly increasing the baseflow of the streams. Summer winds are usually from the northwest and often are strong and steady at 10 to 20 knots (12–23 miles per hours).

Fall weather patterns are typically dryer, with onshore high pressure resulting in an offshore, reverse flow. Winds blowing from the hot desert interior of the west and south, similar to the infamous Mono and Santa Ana winds, bring hot, dry conditions and high fire hazard.

Air Resources

By virtue of the presence of the Phillip Burton wilderness, PRNS is a Class 1 Air Quality Area and is to be managed to protect and preserve clean air values. The Clean Air Act (42 U.S.C. 7401-7671q) provides a legal framework for the NPS to preserve and protect parks' air quality related values from pollution sources emanating from within and outside park boundaries. Class I park areas, those containing legislated wilderness, are to be provided the highest level of protection to prevent significant deterioration of air quality related values.

Air quality at PRNS is generally excellent throughout much of the year due to a stationary marine high-pressure system. During fall, as high pressure systems move off the coast, stagnant polluted air from the metropolitan San Francisco Bay Area can affect the Point Reyes area for a number of weeks. The NPS began air quality monitoring for criteria (O_3) gasses, particulate matter, and visibility in 1987. Criteria monitoring was discontinued in 1992 due to lack of funding. An IMPROVE sampler and visibility camera remain in operation. Long-term vista monitoring is accomplished every five years.

Geology and Topography

The character of the Point Reyes Peninsula has been shaped and defined by its association with the San Andreas Fault. The Peninsula, lying west of the fault, is a fragment of the Pacific Plate that is shifting northwest in relation to the continental North American plate. It is now widely accepted that the total slip on the San Andreas and its main branches in Southern California is about 205 miles. The Salinian granite bedrock of the Peninsula is most closely related to that observed at Montara Mountain in San Mateo County. Bolinas Ridge and lands east of the fault are underlain by Franciscan formation sedimentary rock. The geomorphology, hydrology, weather, soils, and plant communities east of the fault zone differ in many ways from that of the Peninsula.

Granite bedrock commonly called granodiorite underlies the entire Peninsula and is exposed in areas of the Inverness Ridge, Tomales Point, and the Point Reyes Headlands. Granite is overlain by Monterey Shale in the southern part of the Peninsula and is exposed along the coastline from Drakes Bay southward. Coastal wave cut benches and flooded valleys are the result of sea level fluctuations during the Pleistocene and tectonic uplift. The Point Reyes Plain extending from Inverness Ridge west to the Headlands is underlain by siltstone and mudstone of the Drakes Bay Formation. The Headlands present the most unique exposed formation within the park – the Point Reyes Conglomerate – comprised of cobbles of chert, volcanic rock, and granite. It is best exposed along the Lighthouse steps, and is most similar in composition to a conglomerate that occurs on the Monterey Peninsula, 100 miles to the south (Evens 1993). It is thought that the Point Reyes conglomerate was carried northward by the San Gregorio fault (Kingsmark 1998).

The Olema Valley, extending from Bolinas Lagoon to Tomales Bay, is associated with movement along the San Andreas Fault. The fault zone is 0.5 to 1.0 mile wide in the valley. Past movements have created fault topography, including linear ridges, offset stream drainages, offset rows of trees, and sagponds. The surface rupture caused by the 1906 earthquake ran from Bolinas Lagoon to Tomales Bay with a maximum displacement of 14 to 16 feet in the Point Reyes area.

Bedrock east of the fault (generally east of Highway 1) is a Franciscan assemblage that underlies much of California's Coast Range. Franciscan rocks consist primarily of shale and sandstone with occasional beds of limestone and chert along with intrusions of igneous serpentine (Evens 1993). The Franciscan formation is highly unstable, and known for slope instability, thin soils, and high runoff rates.

The current topography of the project area is also defined by numerous stream courses. Drainage patterns are primarily dendritic, resembling the pattern made by the branches of a tree or veins of a leaf. Dendritic drainages may develop in areas with consistent soil types such as the Bolinas Ridge. A number of drainages, however, have drastically altered courses attributed to the combination of stream capture and alterations of the topography caused by fault movement. In the Olema Valley, Olema Creek and Pine Gulch Creek run parallel, but in opposite directions for over two miles. Near the north end of the Valley, Bear Valley Creek runs at an acute angle through the ridge line, then makes an abrupt ninety degree turn to run parallel to Olema Creek until they discharge into the Lagunitas Creek.

Inverness Ridge forms the backbone of the Point Reyes peninsula, reaching a height of 1,407 feet at Mount Wittenberg. The ridge is characterized by relatively consistent upland elevation with sharp precipices dropping down into the river valleys. The only interruption in the ridge, between Bolinas and Tomales Point is the 400-foot pass between Bear Valley and Coast Creek drainages. Most of the perennial streams within PRNS originate from the ridge. South of Laguna Creek, the ridge merges with the Bolinas Mesa, an uplifted, wave-cut Monterey Shale bench. This terrace is intersected by a number of steep ravines caused by drainages cut down to the current sea level. Some of the most spectacular landmarks in PRNS, including Arch Rock and Alamere Falls, are on this terrace.

Bolinas Ridge to the east rises to approximately 800 feet in elevation. Due to soil type and climate, conditions are far drier on these west-facing slopes. Ridges are primarily grasslands with the steep tributary valleys dominated by oak and bay laurel.

Resources that May be Affected

This section describes the type of resources that may be affected or changed by actions in any of the alternatives and their current condition.

Water Resources and Water Quality

The water resources within the project area include a substantial number of perennial and intermittent streams, human-made impoundments, wetlands, natural lakes, and sag ponds. A general map of the watersheds within the project area is shown above. The water resources support a variety of threatened and endangered species including coho salmon, steelhead trout, California freshwater shrimp, and California red-legged frog.

Tomales Bay Watershed. The Tomales Bay watershed includes over 200 square miles, much of which is managed as public land by the NPS, Marin Municipal Water District, California State Parks, and Marin County Open Space. Though it accounts for only 50% of the Tomales Bay Watershed, Lagunitas Creek, including Olema and Bear Valley creeks, contributes more than 65% of the freshwater flow to Tomales Bay. Walker Creek accounts for approximately 1/3 of the watershed area and 35% of the freshwater inflow to Tomales Bay. The remaining watersheds east and west of the Bay make up more than 15% of the land area but contribute only 10% of the freshwater inflow (Fischer et al. 1996) to the west. Small watersheds draining from the east and west sides of the Bay account for only 10% of the overall freshwater contribution to the Bay.

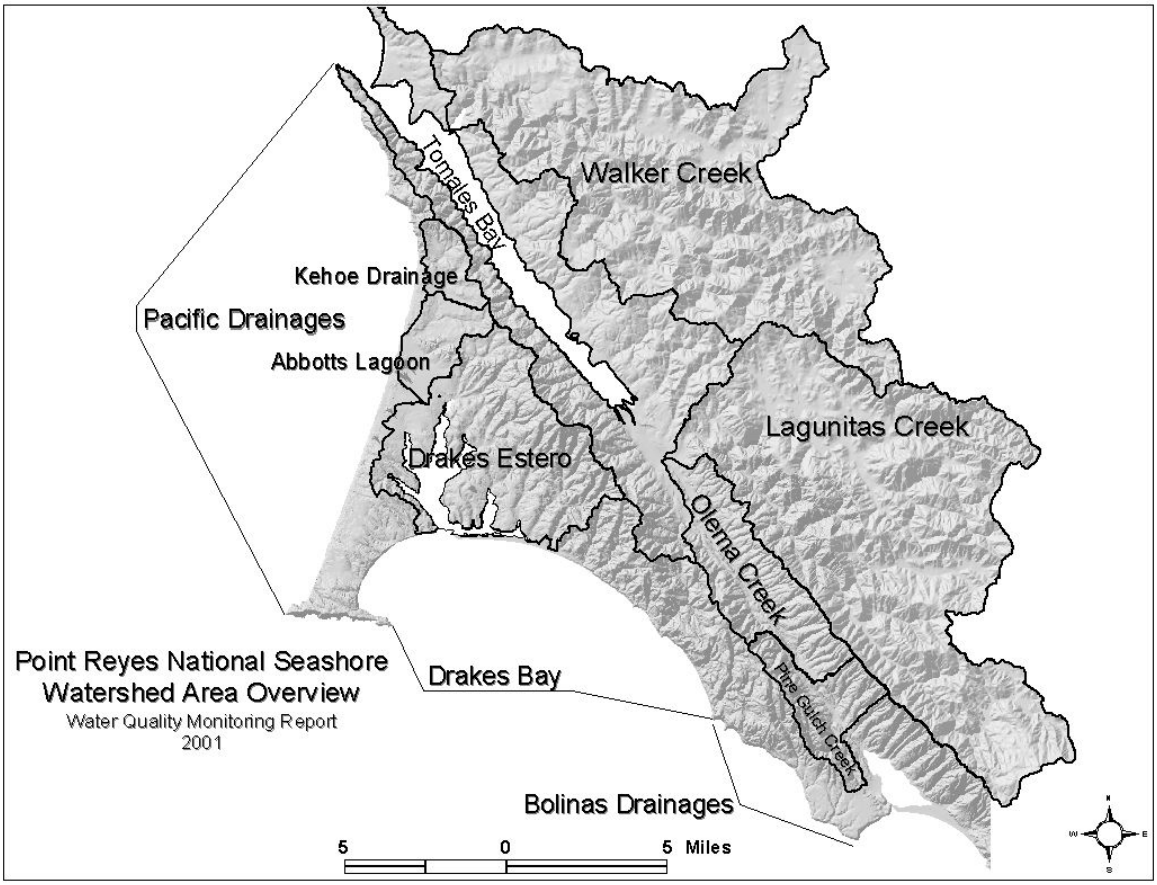
Tomales Bay and Drakes Estero are home to a number of oyster production operations accounting for nearly 35% of the oyster production in the state of California. In 2000, Tomales Bay was identified as impaired by sediment, nutrients, and fecal coliform by the San Francisco Bay Regional Water Quality Control Board. The Board also identified Lagunitas Creek as impaired by the same constituents.

Lagunitas Creek Watershed. Lagunitas Creek drains to the head of Tomales Bay. The 88 square mile watershed is the major supplier of water to most of Marin County through the Marin Municipal Water District. Four dams with storage in excess of 60,000 acre-feet have substantially altered both the hydrology and condition of anadromous populations. The damming of Lagunitas and Nicasio creeks has eliminated nearly two thirds of the spawning habitat of these threatened populations.

The major undammed tributaries heading upstream include Bear Valley Creek, Olema Creek, McIsaac Gulch, Cheda Creek, Devils Gulch, and San Geronimo Creek. The watershed is important as it supports viable populations of federally endangered coho salmon (*Oncorhynchus kisutch*) and steelhead trout.

Other federal threatened and endangered species including California red-legged frog (*Rana aurora draytonii*) and California freshwater shrimp (*Syncharis pacifica*) occur in the watershed.

FIGURE 3: MAP OF THE WATERSHEDS LOCATED WITHIN THE PROJECT AREA.



The 14.5 square mile Olema Creek watershed supports viable populations of federally Endangered coho salmon and steelhead trout. Olema Creek has been the subject of extensive monitoring to determine the effectiveness of various stream protection measures – including riparian exclusion fencing and habitat restoration.

Drake's Bay Watersheds. Drake's Estero and the Estero de Limantour comprise a complex estuarine system capturing flow from more than 35 square kilometers and draining through the Estero inlet. Major watersheds contributing to this system are Laguna, Muddy Hollow, Glenbrook, Home Ranch, East and North Schooner Creek, also support populations of steelhead trout. Other watersheds flowing to the system, but not likely to support salmonids include Creamery Creek, Limantour Creek, North Home Ranch, and Berries Bay Creek. The Estero is susceptible to nutrient and other inputs from adjacent ranches and dairies.

Other Drake's Bay watersheds are characterized as rather small, steep drainages, discharging directly to the beach. In most cases, the wave action forms a seasonal lagoon at the mouth of the stream. The primary watersheds south of Drakes Estero include Coast Camp, Santa Maria (Machado), Coast, Wildcat, and Alamere Creeks. Minor watersheds include Elk Gulch, Woodward Valley, and Kelham Creek. Watersheds east of the Estero include Horseshoe (D Ranch), Drakes Beach, C Ranch, B Ranch, and A Ranch.

Pacific Ocean Watersheds. The primary watersheds draining to the open ocean are from the north, and include McClures, Kehoe North, Kehoe South, E Ranch and Lighthouse. There are a large number of drainages north of Kehoe Beach that drain to the ocean including Elk Fence, White Gulch East, and others. There are also a number of intermittent dune watersheds that are not included in this list but occasionally drain to the ocean across the ten-mile beach. North and South Kehoe Creeks converge approximately ¼ mile upstream of Kehoe Lagoon.

The Abbott's Lagoon watershed drains across gently sloping terrain and into a unique lagoon environment. A human-made pond and a dual chambered lagoon separated by a bedrock sill provide a unique combination of brackish and freshwater environments in a system that often has the same surface water elevation. The lagoon does not breach regularly, remaining closed for years at a time.

Bolinas Drainages. The Bolinas drainages include Double Point, Arroyo Hondo, and RCA. In the late 1970s, arrangements regarding water supply to the town of Bolinas were made with the NPS. To protect streamflow of the Pine Gulch Creek watershed, an agreement with the Bolinas Community Public Utilities District was made that transferred water rights to the Arroyo Hondo Creek. The sole Bolinas Community Public Utilities District water supply, the Arroyo Hondo watershed is the most remote in the Seashore.

Pine Gulch Creek. Pine Gulch Creek is the largest watershed draining to the Bolinas Lagoon. Within the project area, the watershed was the most heavily logged with impacts spread over approximately 100 years. The lagoon is the subject of an intensive study, and a restoration plan coordinated through the US Army Corps of Engineers. Of greatest concern in this watershed is the protection of the stream and lagoon from excess sediment mobilization and deposition, along with the documented return of coho salmon to the watershed.

Impoundments, Natural Lakes, and Sag Ponds

The project area contains more than 125 impoundments or sag ponds known to support the California red-legged frog. Most of these facilities were constructed by former landowners for stock watering or development. The condition of these ponds is not well known although the stability of many is likely compromised by the presence of brush and trees on the dam structure.

Within the Olema Valley, a number of sag ponds associated with the San Andreas Fault provide unique aquatic habitat. The southwestern part of the project area, from Palomarin to Double Point is dotted with ponds and lakes derived from massive slope failure events. These water bodies, such as Bass, Pelican, and Crystal Lake are naturally occurring. A number of smaller ponds occur along Coast Trail from Palomarin.

Soils

The soils of the project area west of the San Andreas Fault are broadly classified with relation to underlying lithology (Evens 1993) as described below:

The Kehoe-Sheridan soils are about three feet deep, well drained, strongly acidic, and are derived from sandstone and quartz diorite. Located on the north flank of Inverness Ridge from Tomales Point south to Tomales Bay State Park, these soils support the bishop pine forests.

The Palomarin-Wittenberg complex is five feet or more deep, well drained, strongly acidic, and is derived from sandstone and shale. These soils occur on the southern half of Inverness Ridge, and support primarily Douglas fir forest.

The Tomales-Steinbeck soils are comprised of fine clays or silts, are slightly to moderately acidic, and are derived from the soft sandstone of the Drake's Bay Formation. They occur from outer Point Reyes south to Point Resistance, and surround Drake's and Limantour Esteros. They support primarily grassland and coastal scrub.

The Pablo-Bayview soils are well drained, shallow (10–20 inches deep), and are derived from weathered shale and sandstone. They occur in a narrow band at the base of the western slope of Inverness Ridge.

The Dune-Sirdrak soils are the wind-blown sands that comprise the dunes. They can be up to six feet deep and have little ability to hold water.

The Cronkhite-Dipsea-Centissima soils are approximately five feet deep and are derived from sandstone and shale. They occur at the Bolinas Mesa at the southern end of the peninsula.

Sand dunes border the ocean around much of the Seashore. In some areas the dunes may extend inland for up to a mile. This soil type is highly susceptible to wind and water erosion, although these processes are part of the natural environmental forces. In the last few decades, European dunegrass was planted in an attempt to control the expansion of dunes into grasslands used for grazing. There is currently a large-scale restoration project to remove this dunegrass and restore natural dune function to the system.

Soils east of the San Andreas Fault (primarily in GGNRA North District) are derived of Franciscan lithology. The Tocaloma and Sheridan soils are moderately deep, well-drained soils. Though well drained, there is no underlying lithology to store the water.

Vegetation

PRNS owes much of its distinctive character to the assemblage of plants that occur on the peninsula. Plant communities create patterns over the Seashore's landscape that reflect the underlying influences of geologic formations and soils, and the overlying influences of a moist, maritime climate. The location of the project area at the midpoint of the Pacific Coast places it at a boundary of two climatic provinces, which results in abundant and varied plant life. The Seashore is known to support over 900 plant species, including approximately 300 non-native species, and 50 species of concern to park managers. The latter include the federally endangered beach layia (*Layia carnosa*), Tidestrom's lupine (*Lupinus tidestromii*), Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*), Sonoma spineflower (*Chorizanthe valida*), and robust spineflower (*Chorizanthe robusta*).

Vegetation in the project area has been subject to human activities for 7,000 – 10,000 years, since the Coast Miwok first occupied the land. Although data are not available on the effects of Miwok activities on vegetation, it is assumed that they gathered plants for food and shelter materials, and probably used fire to manipulate the growth of plant species (Cook 1943). Beginning in the mid-nineteenth century and continuing into the present, activities such as land clearing, logging, cultivation, cropping, road building, commercial development, and livestock grazing have markedly affected the vegetation.

For purposes of analysis, the project area has been divided into 9 broad vegetation types. Acreage estimated for each type in the project area and brief descriptions are presented below. Acreage was estimated from the Point Reyes vegetation map and is rounded to the nearest 100 acres. Vegetation types correspond most closely to the community level in the vegetation map classification hierarchy.

Forest/Woodland Types

1. Bishop Pine (3,700 acres) – Bishop pine (*Pinus muricata*) is the dominant tree in the forest canopy. Madrone (*Arbutus menziesii*), tanoak (*Lithocarpus densiflorus*), coast live oak (*Quercus agrifolia*), or California bay (*Umbellularia californica*) are often present in substantial cover. Huckleberry (*Vaccinium ovatum*) is important to dominant in the shrub layer. Other species common in the understory include salal (*Gaultheria shallon*) and swordfern (*Polystichum munitum*). Stands of bishop pine tend to be even-aged, usually originating after stand destroying fires. The bishop pine forests in the project area are mature forests except for those that burned in the Vision Fire of 1995. Bishop pine forests occur on the northern portions of Inverness Ridge. Approximately 35% of these forests burned in the Vision Fire. These burned bishop pine forests are characterized by a patchwork of extremely dense stands of 12-15 ft. tall trees, as of this report, regenerating pines alternating with extremely dense stands of blue blossom (*Ceanothus thrysiflorus*) and Marin manzanita (*Arctostaphylos virgata*).

This vegetation type also includes a small amount of non-native Monterey pine/Monterey cypress stands; less than 5% of total acreage. These stands are characterized by planted groves dominated by either Monterey pine (*Pinus radiata*) or Monterey cypress (*Cupressus macrocarpa*), invasive in some areas, usually with sparse to low shrub and herbaceous cover. Understory species are often non-native.

2. Douglas fir/Coast Redwood (18,700 acres) – These are forests of giant pointed-crowned conifers with a maximum height approaching 50-70 meters dominated by Douglas fir (*Pseudotsuga menziesii*) or coast redwood (*Sequoia sempervirens*). Approximately 90% of these forests are dominated by fir, with redwood forests making up the remaining 10% or so of this type.

Douglas fir forest in the project area is characterized by Douglas fir dominant canopy often with a strong component of hardwood trees, usually California Bay (*Umbellularia californica*), but tanoak (*Lithocarpus densiflorus*) or individual coast live oaks (*Quercus agifolia*) may be present. Fir is the most common forest in the project area with a highly variable tree canopy cover that may be as low as 15%. The shrub understory is also highly variable, but is usually moderate to very dense. Coffeberry (*Rhamnus californica*), huckleberry (*Vaccinium ovatum*), California hazel (*Corylus cornuta*), poison oak (*Toxicodendron diversilobum*), and coyote brush (*Baccharis pilularis*) are the most common shrubs. Swordfern (*Polystichum munitum*) often dominates the herbaceous layer.

Where redwood is dominant in the forest canopy, tanoak is often a major component, sometimes co-dominating with redwood. California bay or Pacific madrone (*Arbutus menziesii*) are also often present in substantial cover. California hazel and huckleberry are the most common understory shrubs, with shrub cover usually sparse to moderate. Sword fern often dominates the herbaceous layer.

3. Hardwood Forest (7,500 acres) – This type includes forests dominated by hardwood species such as California bay (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), eucalyptus (*Eucalyptus globulus*), tanoak (*Lithocarpus densiflorus*), madrone (*Arbutus menziesii*), or giant chinquapin (*Chrysolepis chrysophylla*). California bay is by far the most abundant forest comprising roughly 75% of this type. Coast live oak makes up about 20% of the type, with the two species often associating with each other. Of the remaining forest, eucalyptus is less than 5% and tanoak, madrone, and giant chinquapin are each less than 1% of this type.

California bay forest canopy is dominated by California bay or co-dominated by bay and coast live oak with each species comprising 30-60% relative canopy cover. Tanoak, Douglas fir (*Pseudotsuga menziesii*), or California buckeye (*Aesculus californica*) may have substantial cover. The understory is variable; it can be a moderately dense shrub understory often dominated by hazel (*Corylus cornuta*), coffeeberry (*Rhamnus californica*), elderberry (*Sambucus racemosa*), and/or poison oak (*Toxicodendron*

diversilobum). If there is no substantial shrub cover, swordfern (*Polystichum munitum*) usually dominates understory.

Coast live oak woodlands are dominated by coast live oak usually with a major component of California Bay, sometimes co-dominating with bay. Douglas fir individuals may be present. Understory is usually open to moderate with poison oak being the most commonly found shrub, often fairly high in cover. Coffeeberry, coyote brush (*Baccharis pilularis*), toyon (*Heteromeles arbutifolia*), and hazel can be present. Herb cover is usually low.

Eucalyptus forests are dominated by the non-native blue gum eucalyptus. These have been planted or have invaded native communities. Eucalyptus is usually very dominant in the canopy. Monterey pine (*Pinus radiata*)/Cypress (*Cupressus macrocarpa*) or individuals of Douglas fir, California bay, or coast live oak may be present. Understory is usually sparse, often including remnants of the native community. Poison oak and non-native or native berry (*Rubus spp.*) are common shrubs. Other non-native shrubs and herbs are often present in low cover. Eucalyptus forests are characterized by a thick litter layer formed by this species distinctive peeling bark, and tendency to drop seedpods, twigs, and branches.

4. Riparian Forest/Shrubland (2,300 acres) – These are streamside forests and shrublands dominated by broad-leaved deciduous trees or shrubs: red alder (*Alnus rubra*), mixed willows, and arroyo willows (*Salix lasiolepis*). Red alder forest is the most abundant of this type; it makes up approximately 70% of riparian areas. Red alder dominates the canopy with California bay (*Umbellularia californica*) often present in substantial cover. Arroyo willow may form a subcanopy to the alder. Understory is usually moderate to dense. Berry species (salmonberry—*Rubus spectabilis*, thimbleberry—*R. parviflorus*, California blackberry—*R. ursinus*), and red elderberry (*Sambucus racemosa*) are the common shrubs. Hedgenettle (*Stachys ajugoides*), sedges (*Carex spp.*), rushes (*Juncus spp.*), small-fruited bulrush (*Scirpus microcarusp*), and ferns (sword fern—*Polystichum munitum*, lady fern—*Athyrium felix-femina*) dominate the herbaceous layer.

Other forested riparian areas are dominated by mixed willow forest, which in the project area is represented by yellow willow (*Salix lucida*), often associating with other willows. Mixed willow forest makes up less than 5% of riparian areas.

Arroyo willow shrublands make up approximately 25% of the riparian type. Arroyo willow in its shrub form, usually 5-7 meters in height, strongly dominates the canopy. Other taller willows, or alder may be present in small quantities. The understory is usually extremely dense because of the thicket-forming growth habits of this species. Shrubs such as berry species (*Rubus parviflorus, R. spectabilis, R. ursinus*) are most commonly found woven through the understory. Wax myrtle (*Myrica californica*) or poison oak (*Toxicodendron diversilobum*) may be present. Sedges, rushes, small-fruited bulrush along with hedgenettle, beeplant (*Scrophularia californica*) and the ferns (Lady fern, bracken fern—*Pteridium aquilinum*) dominate the herbaceous layer.

Scrub Types

5. Coastal scrub (17,800 acres) – This vegetation type is highly variable and includes all of the shrublands of the study area as well as a small amount of chaparral. Approximately 90% of coastal scrub is dominated by coyote brush (*Baccaris pilularis*), a small-leaved evergreen shrub. Coyote brush scrub is highly diverse and variable, ranging from fairly low open areas where coyote brush associates with grasses, to tall dense multi-species scrubs. Coyote brush scrub can be roughly equally divided in the project area between these open and dense variations. In its more open variation coyote brush commonly associates with non-native and native grasses and California blackberry (*Rubus ursinus*). It may also be found in association with sedges (*Carex spp*.) and rushes (*Juncus spp*.). In its taller, denser variation,

poison oak (*Toxicodendron diversilobum*) is the most commonly associating shrub, often in fairly high cover. Coffeeberry (*Rhamnus californica*), thimbleberry (*Rubus parviflorus*), California blackberry, and California sagebrush (*Artemisia californica*) are also common associates in dense coyote brush scrub. An additional 5% or so of coastal scrub is dominated by a diverse list of shrub species that includes coffeeberry, yellow bush lupine (*Lupinus arboreus*), hazel (*Corylus cornuta*), and blue blossom (*Ceanothus thrysiflorus*).

Chaparral accounts for less than 5% of the coastal scrub type. The manzanitas (*Arctostaphylos spp.*), primarily Eastwood manzanita (*Archtostaphylos glandulosa*), and chamise (*Adenostoma fasciculatum*) are the dominant shrubs here. These evergreen species tend to be in the hotter, drier areas with the largest occurrences in the project area found on the western slope of Bolinas Ridge and within the Vision Fire burn area on Inverness Ridge.

Herbaceous Types

6. Grassland (20,300 acres) – This variable vegetation type is dominated by non-native or native grasses, much of which are grazed by cattle, and may have up to 15% shrub cover. Roughly 80% is dominated by non-native grasses, the remaining 20% or so by native grasses. Purple velvet grass (*Holcus lanatus*) is the dominant non-native perennial grass in the project area. Italian wild rye (*Lolium perenne*) is also important. Non-native European dunegrass (*Ammophila arenaria*) is included in the coastal dune type. Dominant non-native annuals are annual Italian wild rye (*Lolium multiflorum*), Farmer's foxtail (*Hordeum murinum*), and rattail fescue spp. (*Vulpia spp.*). Non-native grasses are usually found in association with coyote brush (*Baccharis pilularis*), California blackberry (*Rubus ursinus*), native and weedy herbs, and often remnant native grasses.

Pacific reedgrass (*Calamagrostis nutkaensis*) is the most common native grass in the project area, along with tufted hairgrass (*Deschampsia cespitosa*), California oatgrass (*Danthonia californica*), meadow barley (*Hordeum brachyantherum*), and California brome (*Bromus carinatus*). Where Pacific reedgrass is in association with rushes (*Juncus spp.*) and sedges (*Carex spp.*) it is included in the wetland vegetation type. Native grasses are often found in association with annual non-native grasses, coyote brush, California blackberry, and a variety of native and weedy herbs.

7. Pasture (3,900 acres) – These areas are used as enclosed pastures to graze cattle or horses and are managed to produce silage for cattle; or are fields used for other agricultural purposes. This is an artificial vegetation type and is distinguished from grazed grasslands and other grazed naturally occurring vegetation types in the project area.

8. Coastal Dunes (1,900 acres) – The majority of dune habitat has been completely dominated by the non-native species European beachgrass (*Ammophila arenaria*), consisting of roughly 50% of this type, or iceplant (*Carpobrotus edulis*), consisting of roughly 25% of this type. In areas where these two species dominate, they form dense monocultures, with little to no other species present.

The remaining 25% of this type are remnant patches of native habitat, which commonly support primarily dune sagebrush (*Artemisia pycnocephala*), coast buckwheat (*Eriogonum latifolium*), dune lupine (*Lupinus chamissonis*), or goldenbush (*Ericameria ericoides*), often with substantial cover of the two invasive species, European beach grass and/or iceplant. Total vegetation cover is often low and interspersed with bare sand.

9. Wetlands (2,900 acres) – This is a varied group that includes moist herbaceous wetlands, salt marshes, and freshwater marshes. Moist herbaceous wetlands, dominated by rushes (*Juncus spp.*), sedges (*Carex spp.*), small-fruited bulrush (*Scirpus microcarpus*), and Pacific reedgrass (*Calamagrostis nutkaensis*) in

association with these wetland species, make up approximately 70% of this type. Any of these species may dominate, however they are often found in swales in a patchwork pattern. Common dominants are rush (*Juncus effusis*), slough sedge (*Carex obnupta*), small-fruited bulrush, and Pacific reedgrass often associating with other rush or sedge species. Other associating species include purple velvet grass (*Holcus lanatus*) and California blackberry (*Rubus ursinus*) in the drier areas, potentilla (*Potentilla anserina*), hedgenettle (*Stachys ajugoides*), lady fern (*Athyrium felix- femina*), and horsetail (*Equisetum spp.*) in the moister areas.

Salt marshes make up roughly 30% of wetlands in the project area. Pickleweed (*Salicornia virginica*) is the most common dominant, as well as saltgrass (*Distichlis spicata*); these species often co-dominate. Jaumea (*Jaumea carnosa*) is the most common associate. Sea lavender (*Limonium californicum*), arrow-grass (*Triglochin concinna*), alkali heath (*Frankenia salina*), and bird's beak (*Cordylanthus maritimus*) are often associates as well.

Freshwater marshes account for less than 5% of this type. Dominant species are the tall California bulrush (*Scirpus californicus*) and cattails (*Typha spp.*). These species are found in the wettest areas in or at the edge of standing water such as marshes or stock ponds. Bur-reed (*Sparganium spp.*) and water parsley (*Oenanthe sarmentosa*) are common associates.

Wildlife

The project area supports a wide diversity of wildlife species, including 28 species of reptiles and amphibians, 65 species of mammals, over 470 bird species (representing 45% of the avian fauna documented in the United States), and uncounted invertebrates. The waters of the Pacific Ocean and Tomales Bay support rich and diverse fisheries. The US Fish and Wildlife Service and/or the State of California list many of the wildlife species present in the study area. The Marine Mammal Protection Act and the Migratory Bird Treaty Act afford additional protection.

Mammals. A rich diversity of terrestrial mammals occupies the many habitats of the project area. These include mountain lion *(Felis concolor),* bobcat (*Lynx rufus),* gray fox *(Urocyon cinereoargenteus),* black-tailed deer *(Odocoileus hemionus columbianus*), raccoon *(Procyon lotor),* striped skunk *(Mephitis mephitis),* mink *(Mustela vision),* and the Point Reyes mountain beaver *(Aplodontia rufa phaea).* Some large mammals have been extirpated, including grizzly bear *(Urus horriblis)* and wolf *(Canis lupus),* while others such as the coyote *(Canis latrans)* are beginning to reappear. Some extirpated species, such as the tule elk (*Cervus elaphus nannodes*) have been reintroduced. See below for a more detailed description of native ungulates.

Marine mammals, many of which are endangered under the Marine Mammal Protection Act (e.g., southern sea otter [*Enhydra lutris nereis*], and Steller sea lion [*Eumetopais jubatus*]), inhabit or transit the waters off of Point Reyes. Twenty percent of California's breeding population of harbor seals (*Phoca vitulina*) occur at Point Reyes. In 1981, northern elephant seals (*Mirounga angustirostris*) colonized the Point Reyes Headlands and the colony is growing. Gray whales (*Eschrichtius robustus*) are numerous during winter and spring migrations, and humpback (*Megaptera novaeangliae*), and blue (*Balaenoptera musculus*) whales are frequently observed in summer and fall.

Amphibians and Reptiles. Federally threatened California red-legged frogs (*Rana auroura draytonii*) occur within the project area, as do bullfrogs (*Rana caesbeiana*), California newts (*Taricha torosa*), and rough-skinned newts (*Taricha granulosa*). It is not uncommon to find the Pacific giant salamander (*Dicamptodon enstatus*) near streams.

Birds. Located along the Pacific Flyway and prominently jutting from the coast, the Point Reyes Peninsula supports a large number of resident and migratory birds. Of the 470 bird species that have been documented, 246 are listed as rare in the *Field Checklist of Birds for Point Reyes National Seashore* (1992).

Fisheries. Anadromous fish present in the watersheds of the study area include federally Endangered coho and Chinook salmon (*Oncorhynchus kisutch and Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), Pacific lamprey (*Lampertra tridentata*), sturgeon (*Acipenser medirostris*), California roach (*Hesperoleucus symmetricus*), and Pacific herring (*Clupea pallasi*).

Non-Native Wildlife. Several species of non-native wild and feral animals also occur in the project area. Non-native deer were released in the 1940s and 1950s by a local landowner for hunting. See below for a more detailed description of non-native deer. Non-native and feral predators, such as red fox (*Vulpes vulpes*) and house cats (*Felis domesticus*) are present, as well as several non-native bird species including brown-headed cowbirds (*Molothrus ater*), European starlings (*Sturnus vulgaris*), wild turkeys (*Meleagris gallopavo*), and common peafowl (*Pavo cristatus*). A number of non-native marine invertebrate species and fishes have been introduced into the marine and estuarine systems over the past 100 years at the seashore. Examples include the European green crab (*Carcinus maenas*), Sacramento perch (*Centrarchus macropterus*), and the mosquitofish (*Gambusia affinis*). Most of these were introduced by oyster farming operations, fish introductions or from bilge water pumped from visiting vessels.

Ungulate Biology

Native Tule Elk

Tule elk, one of six subspecies of the North American elk or wapiti (*Cervus elaphus*), are endemic to California, and were almost extirpated at the end of the 19th century by market hunting. They exist today in 22 California herds in a fraction of their historic range, with numbers totaling less than 4000. Tule elk were reintroduced to a fenced, 2600-acre reserve at Tomales Point, in the Seashore, in 1978. Total numbers of tule elk in the Seashore are currently estimated to be 450-500. PRNS is the only National Park unit that supports tule elk.

Tule elk are the largest native herbivore in the California coastal ecosystem, with adult bulls weighing 500 pounds. They are fawn-colored with distinctive white rump patches (Figure 4). They are considered grazers, eating predominantly grasses, and favor non-forested habitat in the Seashore, such as open grassland and coastal scrub. Tule elk mating season is fairly prolonged at PRNS and lasts from August through November. Cows give birth to single calves in the spring and early summer.

Following an initial period of slow growth after re-introduction, the herd showed rapid growth in the late 1980s and early 1990s. Because of concern that the expanding herd might cause irreversible damage to the range and multiple species of concern, a Tule Elk Management Plan was completed in 1998 (NPS 1998). The document, in the form of an Environmental Assessment, was compiled with input from the public as well as recommendations from a "blue ribbon" panel of wildlife biologists and scientists (McCullough et al. 1993). The plan included recommendations for: (1) monitoring tule elk and their environment, (2) research on the feasibility of using immunocontraception in tule elk as a population control method, and (3) relocation of 35-70 animals to the Limantour area.

From 1995-1998, a $300,000 monitoring program was conducted by U.S. Geological Survey (USGS) researchers, and funded jointly by USGS and NPS. During the project, 25 elk cows and 66 elk calves were marked with radio telemetry transmitters and observed for up to 3 years. In 2004-2006, another 60

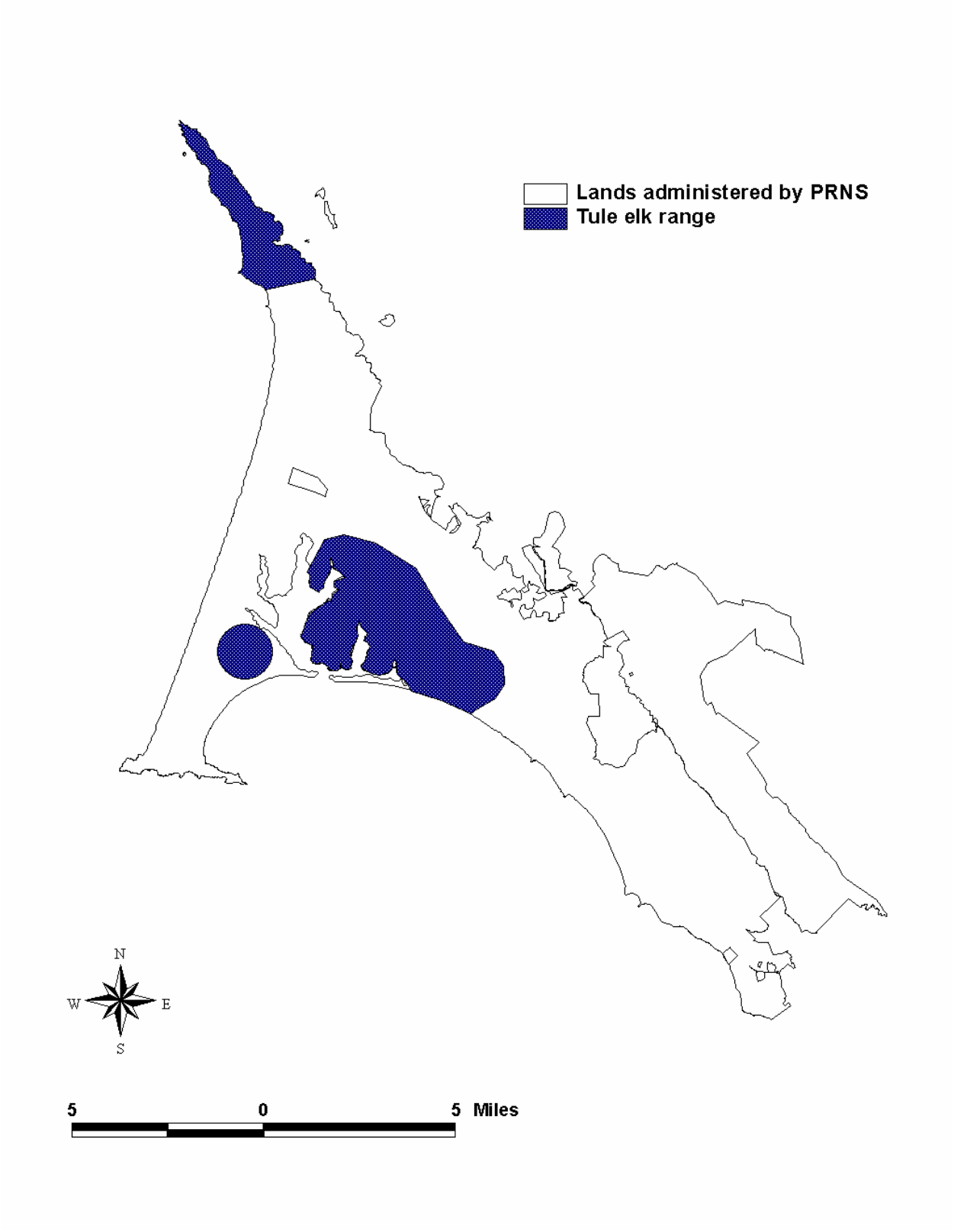
animals will be collared and monitored in another joint USGS-NPS project designed to model elk population dynamics over the next 6-10 years.

From 1997-2001, 40-50 elk cows were given contraception annually for a cooperative NPS-University of California, Davis, study. The contraceptive used, porcine Zona Pellucida (pZP), effectively prevented pregnancy in treated individuals but had only a minor population-wide effect in curtailing herd growth (NPS 2002b). The 1998 translocation of 45 elk to the Limantour area of the Seashore established a free-ranging herd and temporarily slowed growth of the Tomales Point herd. Population counts since 1999 indicate that numbers at Tomales Point may have stabilized at approximately 450. Currently the Limantour herd consists of 45 animals, with 9 new calves born in 2003 (see map, Figure 5).

Forage availability, closely tied to annual precipitation, is likely the most important determinant of elk population growth in the Seashore. Other regulating factors, such as inbreeding, disease and trace element deficiencies, have all been documented in the Tomales Point herd. PRNS tule elk are thought to be among the most inbred in California, with an estimated loss of 80% of their retained genetic variability (McCullough et al. 1996). Paratuberculosis, or Johne's disease, is an exotic, incurable diarrheal wasting disease of livestock and wild ungulates, and has been diagnosed in several elk at Tomales Point since reintroduction (Jessup et al. 1981, PRNS unpublished data (d)). Incidence of the disease, as evidenced by confirmed infection in animals culled before release at Limantour, may be at least 22% in adult Tomales Point animals (Manning et al. 2003). Copper deficiency was evident in the herd in the early 1980s and in 2004 and can cause anemia, decreased reproductive rates, and bone and antler deformities (Blood et al. 1983; Gogan et al. 1989; PRNS unpublished data (e)). How much these stressors account for current herd growth patterns is unknown.

FIGURE 4: TULE ELK (*CERVUS ELAPHUS NANNODES*)

FIGURE 5: TULE ELK RANGE (2005), (BASED ON PRNS ELK GIS DATABASES)



Native Black-Tailed Deer

The Columbian black-tailed deer is one of 9 subspecies of *Odocoileus hemionus*, a species that includes mule deer and Sitka black-tailed deer. Its geographic range spans the coast from southern British Columbia to Santa Barbara County in California, and as far east as the Cascade and the northern Sierra Nevada mountain ranges.

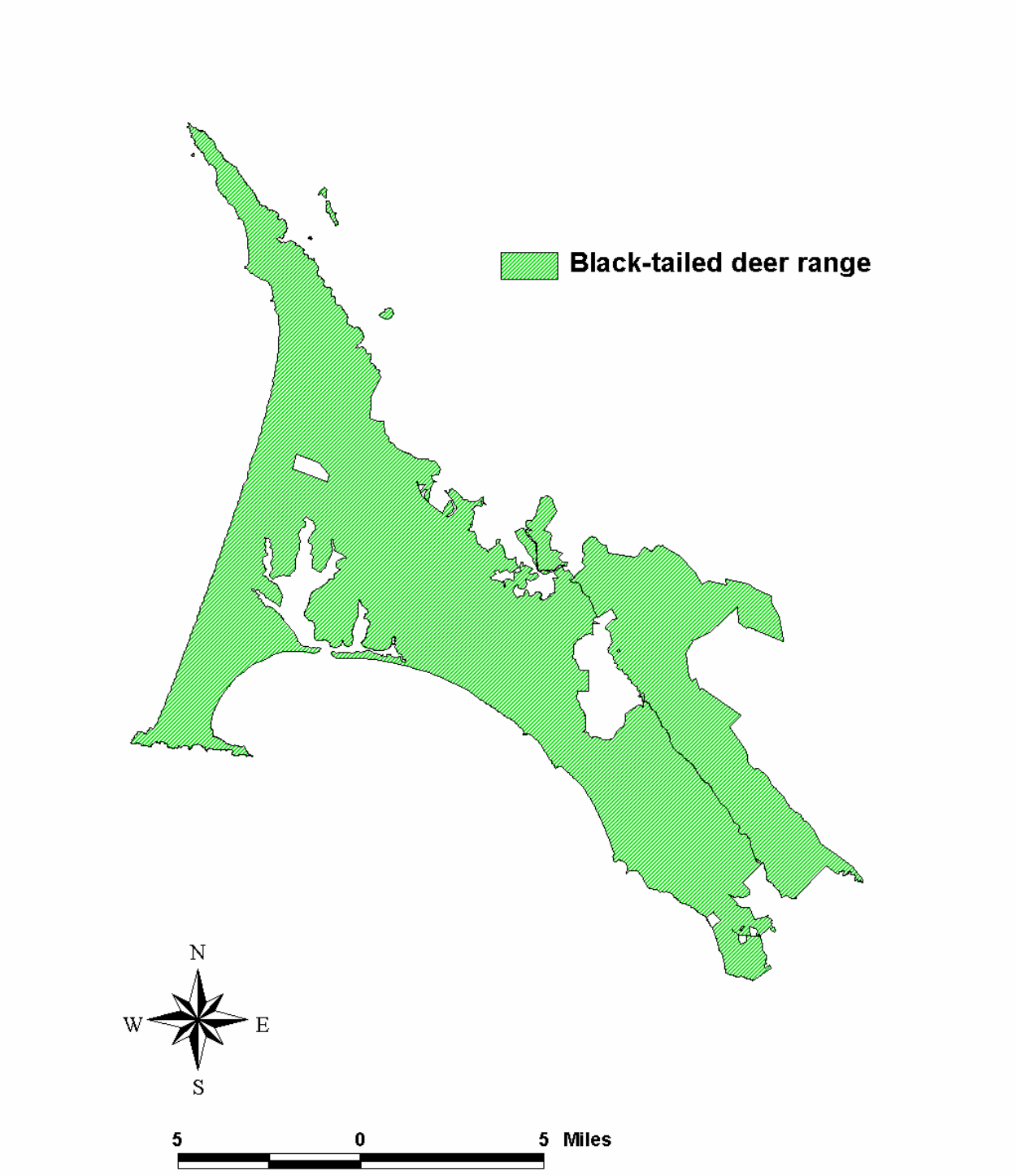
Black-tailed deer are taupe-colored, medium-sized cervids, with adults weighing up to 250 pounds (Figure 6). They are found throughout the Seashore, in coniferous forests as well as coastal scrub and agricultural fields (see map, Figure 7). They are characterized as browsers, consuming some grasses but a preponderance of forbs and shrubs year-round (Gogan and Barrett 1995). Although black-tailed deer can occasionally be found in groups of up to 20-30 animals, they tend to be more solitary than the other Seashore species and are typically found in small familial groups of 2-4 animals. Black-tailed deer mating season, or rut, is confined to the fall and does give birth to single fawns or twins.

The number and population dynamics of black-tailed deer at PRNS have not been extensively documented. In 1980, Thompson estimated a density of 33.9 black-tailed deer per square mile and a population of 1133 $\pm$ 459 animals in the pastoral zone (Thompson 1981). A minimum of 415 were counted during a 2002 park wide aerial census (NPS 2002a).

Various disease and dietary studies of PRNS black-tailed deer have been conducted. California Department of Fish and Game collected 53 black-tailed deer in 1976, along with 118 axis and 119 fallow deer. CDFG scientists concluded that black-tailed deer were in poor physical condition and showed serious effects of disease and parasitic infestation. The study concluded that all 3 deer species competed for similar food items (Brunetti 1976). Elliott also found evidence of dietary overlap between black-tailed deer and non-native deer, especially in times of low forage availability (Elliott 1982). A University of California, Davis researcher tested 134 black-tailed deer fecal samples for the organism that causes Johne's disease. No positive results were obtained and the researcher concluded that the upper limit for Johne's disease incidence in black-tailed deer in the Seashore was 6.2%. Black-tailed deer were judged to pose minimal risk to future Johne's-free elk herds (Sansome 1999). In a review of Elliott's dietary study, Fellers, a USGS researcher, concluded that non-native deer had major adverse impacts on black-tailed deer productivity and survival (Fellers 1983 and 2006). During times of low forage availability, for every 1.2 non-native deer present in the Seashore, the review concluded, one black-tailed deer was lost and at a minimum, the PRNS black-tailed deer population was likely suppressed by at least 40%.

FIGURE 6: COLUMBIAN BLACK-TAILED DEER (*ODOCOILEUS HEMIONUS COLUMBIANUS*)

FIGURE 7: COLUMBIAN BLACK-TAILED DEER RANGE (WITHIN NPS BOUNDARIES)



Axis Deer (Introduced)

Axis deer (*Axis axis*), also called chital, are native to India and Sri Lanka. They are medium-sized deer, weighing up to 200 pounds as adults. They can be distinguished from other deer in PRNS by their coats, fawn or chestnut in color with white spots, and simple, non-palmate antlers (Figure 8). Axis deer are considered grazers, with grasses making up the bulk of their diet, but they eat increased amounts of forbs during the dry season. They are typically found in large herds of up to 150 animals, in open grasslands and agricultural pastures, intermixed with low, open scrub. Because axis deer rut is not confined to a particular season, herds year-round typically contain animals both in velvet and hard antler, pregnant and non-pregnant does, as well as fawns of different sizes. Axis does have been observed breeding as young as 4 months of age and typically give birth to single fawns (Graf and Nichols 1966; Gogan et al. 2001).

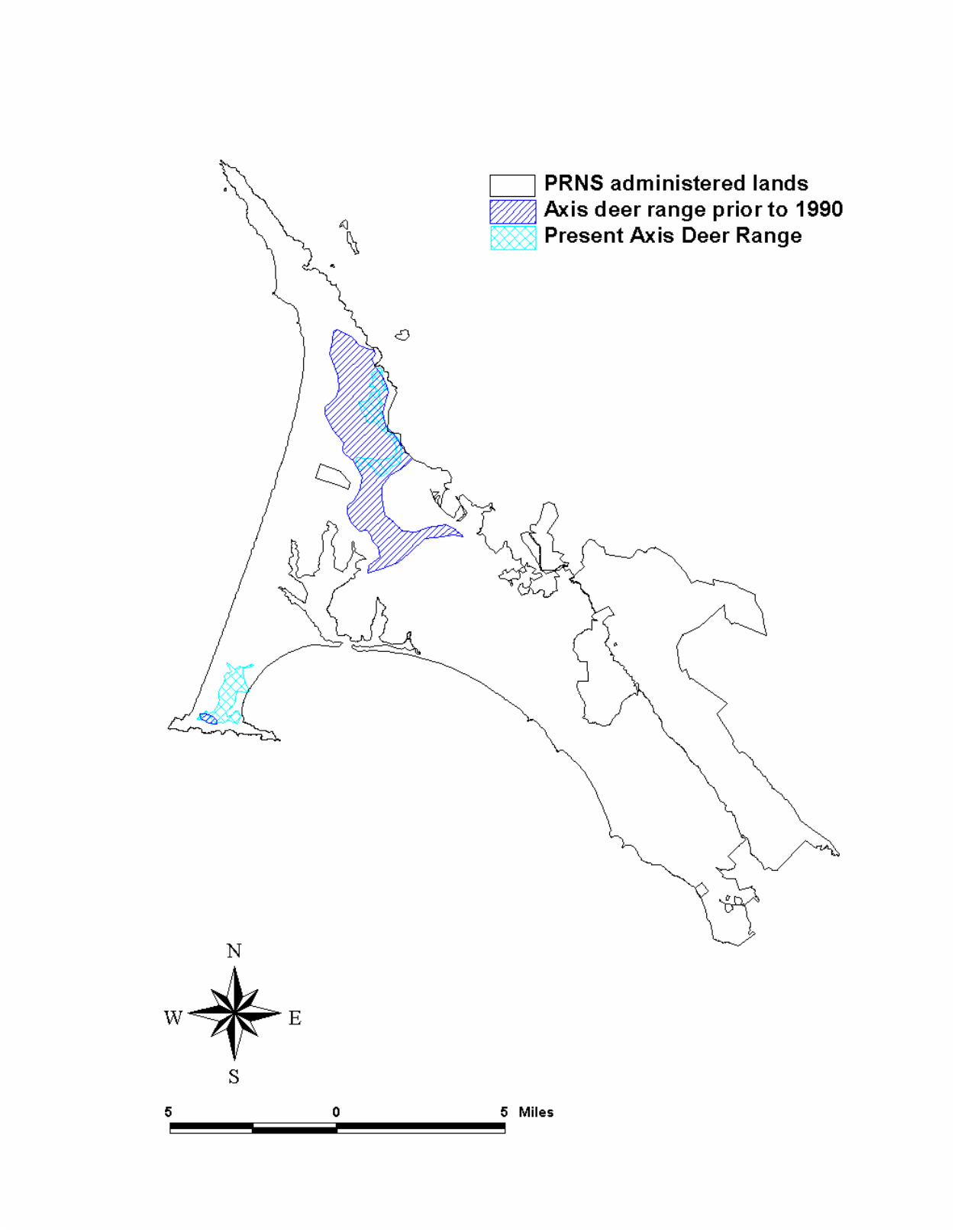
Axis deer have been introduced to many continents, including North and South America, Australia, and Europe. In the United States, large numbers of axis deer exist in a free-ranging state in Hawaii and Texas. Axis deer are frequently found in game ranches throughout the U.S. In their native range, axis deer are considered sufficiently abundant to warrant no special conservation status.

Eight axis deer were purchased from the San Francisco Zoo by a local landowner and released on the western slope of Inverness Ridge in 1947 and 1948 for hunting purposes. When NPS assumed management authority of the parklands in 1962, the axis deer population was well established, with an estimated 400 animals counted in 1973 (Elliott 1973). Currently, their numbers are estimated to approach 250 (NPS 2003). See below for a summary of research on axis deer population, ecology and disease at PRNS.

Axis deer are currently found in largest numbers in the Lighthouse, Chimney Rock, and L Ranch areas of the Seashore (see map, Figure 9). Axis deer are not currently found in designated wilderness. They have been sighted outside of NPS borders, in Tomales Bay State Park and as far east as the Nicasio Reservoir area (PRNS unpublished data (a)).

FIGURE 8: AXIS DEER (*AXIS AXIS*)

FIGURE 9: AXIS DEER RANGE (2003), (BASED ON PRNS NON-NATIVE DEER LOCATION OBSERVATION DATA)



Fallow Deer (Introduced)

Two species of fallow deer are thought to exist: the Persian fallow deer (*Dama mesopotamica*) and the European fallow deer (*Dama dama*). The species found in PRNS, European fallow deer, is thought to be native to Asia Minor, the southern Mediterranean region, and possibly northern Africa. Since Phoenician times, they have been widely introduced throughout Europe, South Africa, Australia, North and South America, and elsewhere. Approximately 28 fallow deer were released from 1942 to 1954 into the Point Reyes area by a local landowner, who purchased them from the San Francisco Zoo for hunting purposes (San Francisco Zoo unpublished records; Wehausen 1973). In 1973, they were estimated to number 500 animals (Wehausen 1973). Currently, fallow deer in the Seashore are thought to number approximately 860 animals (PRNS unpublished data (f)). See below for a summary of research on fallow deer population, ecology, and disease at PRNS.

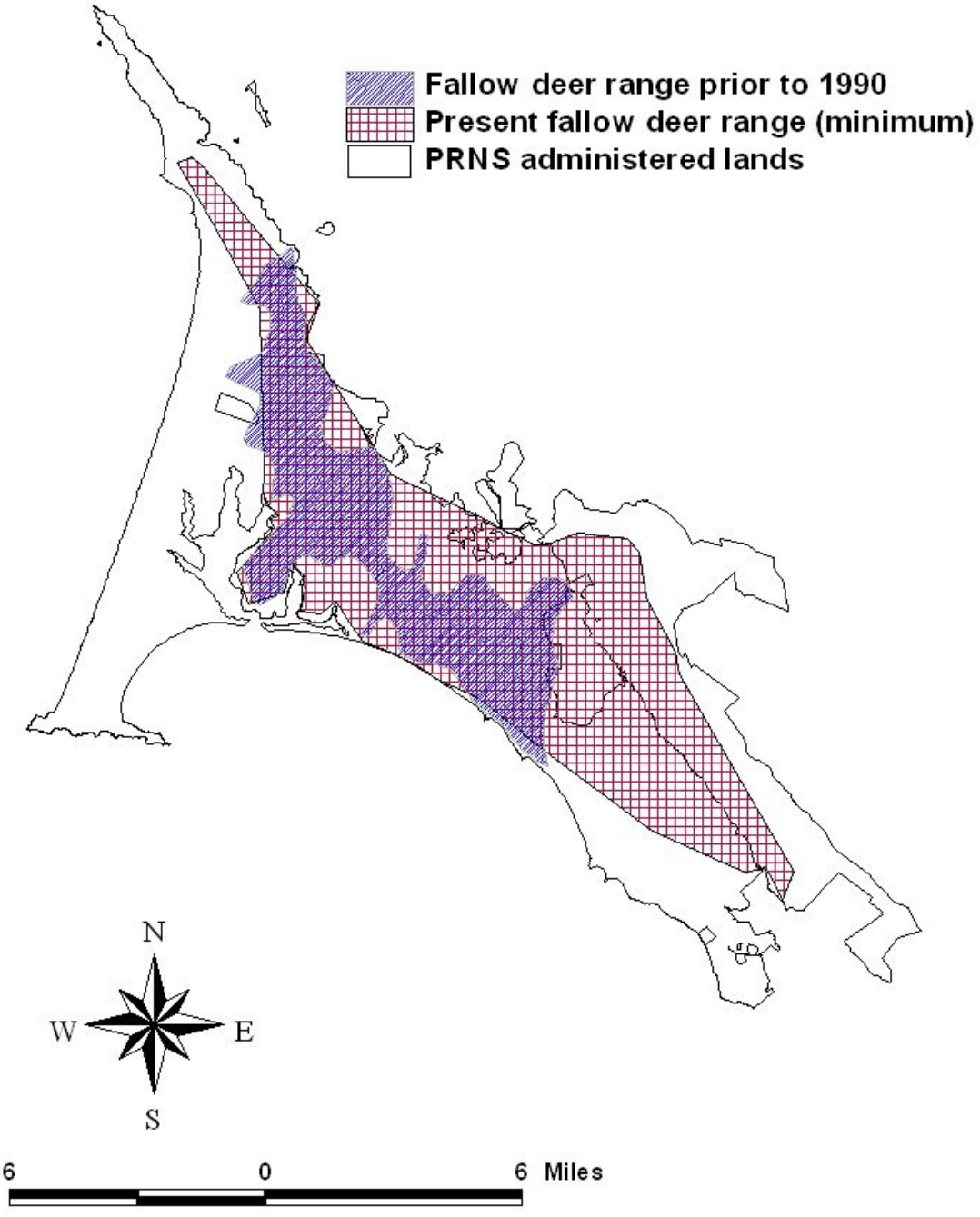
Fallow deer are medium-sized deer, weighing up to 230 pounds. They are found in 4 color variants at PRNS: white, common (taupe colored), black, and menil (brown with white spots) (Figure 10). European fallow deer are distinguished from Persian fallow deer and other deer in the Seashore by their various colors and palmate antlers (D. Saltz, Ben Gurion University, personal communication; C. Penny, San Diego Zoo, personal communication). Fallow deer congregate in mixed or same sex groups of up to 140 animals, depending on the season. Like axis deer, fallow deer are considered grazers, eating predominantly grasses during most of the year and increasing their intake of forbs during times of low forage availability.

Fallow deer at PRNS mate during a well-defined rut season in the fall. They are thought to use a "lekking" breeding system in which bucks remain on small, defended territories (leks). Receptive does are attracted to these leks. At PRNS, lekking behavior has been observed, particularly in Olema Valley where groups in excess of 50 animals return to the same areas each year to mate. Mature bucks mark leks by thrashing vegetation, scraping the ground and urinating, while smaller, younger males wait outside lek boundaries and attempt to mate with stray does. A small minority of males in a population are responsible for the majority of the breeding (Connolly 1981). Fallow does give birth to single fawns in the spring (Wehausen 1973).

Fallow deer are found throughout the Seashore, except in the pastoral areas near Chimney Rock and the coastal scrub near Palomarin (see map, Figure 11). Thirty-five percent of their current range in the Seashore consists of designated wilderness. They are routinely observed outside NPS boundaries in the Vedanta Property, where fallow deer densities can exceed 80 deer / sq. km. (NPS 2002a). They have also been observed in small numbers in Samuel P. Taylor State Park, Paradise Valley near Bolinas, and as far east as the Nicasio reservoir area and Woodacre (PRNS unpublished data (a)).

FIGURE 10: FALLOW DEER (*DAMA DAMA*)

FIGURE 11: FALLOW DEER RANGE (2005), (BASED ON PRNS NON-NATIVE DEER LOCATION OBSERVATION DATA)



History of Research on Non-Native Fallow and Axis Deer at Point Reyes National Seashore and Golden Gate National Recreation Area

Monitoring of non-native deer in the Seashore began after all rancher hunting was discontinued in 1971. The research that followed can be divided into three categories: population, disease, and ecological studies. All publications and unpublished reports are described in the References section.

Population Studies

1972–1973: Wehausen (1973) studied fallow deer demographics and natural history. Through field observations he concluded the 1973 population was 479 and was below carrying capacity levels. He also concluded that the population was increasing at 11% per year (NPS 1984). Elliott (1973) used field observations of axis deer during the same year to conclude that the axis deer population of 401 was also below carrying capacity. He concluded the population was increasing at 22% per year. The main reason for the difference in herd growth rates for the two species was thought to be the age of first breeding, approximately 6 months earlier in axis than in fallow females (Elliott 1973).

1974: California Department of Fish and Game deer collections yielded estimates of population growth rates of 18% and 14.5% per year for fallow and axis deer, respectively. Such high growth rates were thought to be irruptive in nature and the result of a cessation of all hunting in 1972 (Brunetti 1974). Minimum population estimates, based on area ground counts in 1973–1974, were 600 fallow deer and 620 axis deer. Stabilization of both populations at these levels would require yearly removal of 360–420 animals (Brunetti 1975).

1975–1976: Elliott (1976a, 1976b) surveyed axis and fallow deer from the ground and by helicopter during the fall and winter of 1975–1976. He found a minimum of 492 fallow deer and 461 axis deer.

1977: Elliott (1977b) conducted a census of the entire Seashore by helicopter and with area counts and found a minimum of 523 fallow deer and 364 axis deer. He concluded that the deer control program at the time was effective in limiting only the axis deer to the target of 350 per species.

1979: Nystrom and Stone (1979) counted axis deer from the ground and estimated a total Seashore population of approximately 253 with an estimated 25% annual rate of increase.

1980–1982: A line transect census method was attempted but failed to adequately count exotic deer in the pastoral zone (Thompson 1981). Line transect censusing of fallow deer in the southern wilderness zone suggested higher densities of fallow deer (52.6 per square mile or 20 per square kilometer) than previously recorded there (Gogan et al. 1986).

1985: Ground censuses in the pastoral zone were conducted and total numbers of axis deer in the park were estimated to be 328. Fallow deer numbers, in the pastoral zone only, were estimated to be 114 (Ranlett 1985).

2001: Gogan et al. (2001) reviewed PRNS and CDFG data from 1976 through 1980 on non-native deer collections. Based on this data and on the published literature, a population model was developed to predict deer numbers with and without lethal removals. A carrying capacity of 455 for axis deer and 775 for fallow deer was postulated. Researchers concluded that axis deer are relatively vulnerable to eradication by ground shooting. Other conclusions were that NPS control of 1,873 fallow deer from 1968

to 1996 was unsuccessful in reducing numbers to less than 350 and that cessation of control would result in return of both populations to carrying capacity within 13 years (Gogan et al. 2001).

2000–2002: Concurrent helicopter and ground censuses were conducted throughout the Seashore (NPS 2001, 2002a). Minimum estimates of total populations were 475 and 623 for fallow deer in 2001 and 2002 respectively. Using a double survey method in 2002, in which ground and aerial censuses were conducted concurrently, the total fallow population size was estimated to be 771 with a 95% Confidence Interval of 636 to 2,272 animals. Fawn/doe ratios, similar to those of the 1970s, indicated that the fallow population might be below carrying capacity and might continue to increase. Fallow deer densities ranged from 0 to 210 deer per square mile (up to 81 deer per square kilometer) in different parts of the Seashore. Minimum estimates for axis deer were 211 and 229 in 2001 and 2002 respectively and were considered to approximate real population numbers.

Also in 2001, Barrett created a population model based on his previous modeling work in Gogan et al. (2001). In the new model, the effects of yearly contraception in fallow deer could be predicted (Barrett unpublished report 2001). Using the same assumptions of age and sex dependent mortality rates and the same carrying capacity as in Gogan et al. (2001), it was estimated that stabilization of fallow deer populations at 350 could only occur with contraception of approximately 80% of all does of reproductive age with a contraceptive that was 100% effective. Eradication of fallow deer from the Seashore and GGNRA lands by 2050 would require yearly contraception of 99% of all fallow does of reproductive age with a contraceptive that was 100% effective (Barrett unpublished report 2001).

2002–2003: During the winter of 2002–2003, NPS and USGS researchers conducted a mark-resight study of fallow deer at PRNS, using 29 radio-collared deer to evaluate the proportion of animals missed on aerial censuses. The study resulted in an estimate of 859 fallow deer (90% Confidence Interval = 547 - 1170) (PRNS unpublished data (f)). A ground count of axis deer by NPS staff in May 2003, resulted in an estimated population size of 230–250 animals and an observed fawn/doe ratio of 1 fawn for every 3 adult does (NPS 2003).

Also in 2003, Hobbs created a stage-based simulation model to examine the effects of culling and fertility control on fallow deer numbers in PRNS (Hobbs 2003). Using similar assumptions as Gogan et al. (2001), and assuming that density dependence in the population causes a linear decrease in herd growth as it approached a carrying capacity of 1000 animals, Hobbs found that:

- Attempting to eradicate the population in 15 years, using only fertility control (either yearly contraception or longer duration agents), would be futile.

- Approximately 620 fallow does would need to be culled to eradicate the population in 15 years, in the absence of any fertility control.

- Treating animals with contraceptives that are effective for at least 4 years with one dose could reduce the number of animals that would need to be culled in order to eradicate the population.

- Fertility control would not reduce the total number of animals that would need to be handled (either treated or culled).

For a detailed explanation of the assumptions and conclusions of the Barrett and Hobbs population models, see Appendixes B and D.

TABLE 4: SUMMARY OF EXOTIC DEER POPULATION ESTIMATES FROM INTRODUCTION TO 2003

Year	Fallow Deer Numbers	Axis Deer Numbers	Reference
1942 (first introduction of fallow deer)	15		Wehausen 1973
1947 (first introduction of axis deer)	11	4	Elliott 1973, San Francisco Zoo unpublished records
1948		4	San Francisco Zoo unpublished records
1954	2		San Francisco Zoo unpublished records
1973	479		Wehausen 1973
1973		401	Elliott 1973
1974	600*	620*	Brunetti 1975
1976	492*	461*	Elliott 1976a, 1976b
1977	523*	364*	Elliott 1977b
1979		253	Nystrom and Stone 1979
1985		328	Ranlett 1985
2001	475*	211	NPS 2001
2002	623*	229	NPS 2002a
2003	859	230–250	Unpublished PRNS data (f); NPS 2003

* These are minimum counts. True numbers are likely higher.

Disease Studies

1974–1975: During this time, California Department of Fish and Game (CDFG), with assistance from NPS, collected a total of 290 native and non-native deer and performed complete necropsies (Brunetti 1976). The primary purpose of the study was to determine population dynamics, forage habits, and disease prevalence. A secondary purpose of the study was to directly reduce non-native deer numbers. Serological testing in fallow deer showed high exposure to livestock diseases such as bovine viral diarrhea and infectious bovine rhinotracheitis. On necropsy, 54.2% of fallow deer carried liver flukes. A low incidence of lungworm and intestinal parasites were found in both species. CDFG researchers concluded that both populations were relatively healthy and in good condition (Brunetti 1976).

1976–1977: Researchers analyzed serological titers and kidney fat indices (an indication of body condition) on 150 native and exotic deer collected by NPS and CDFG (Elliott 1977a; Riemann et al. 1979a). As in previous studies, they found that the non-native deer were in good physical condition but found evidence of exposure to: bluetongue, Q fever, infectious bovine rhinotracheitis, bovine viral diarrhea, anaplasmosis, toxoplasmosis, leptospirosis, and parainfluenza 3 (Elliott 1977a; Riemann et al. 1979a). Another study on paratuberculosis, or Johne's disease, was conducted with the same collected deer and on cows from 10 dairy herds in and around the Seashore. The causative organism for Johne's disease was found in 8.1% of fallow deer, 9.6% of axis deer, and 8.7% of cows tested (Riemann et al. 1979b).

2000: NPS biologists culled 7 axis deer and 9 fallow deer for disease testing (NPS unpublished data (g)). Lung and intestinal parasites were found and serology showed exposure to anaplasmosis and leptospirosis in one axis and one fallow deer, respectively. One axis deer tested positive for Johne's disease.

2005**:** USDA researchers culled 7 fallow deer and 5 axis deer for a comprehensive survey of ectoparasites occurring on non-native deer ectoparasites. *Bovicola tibialis*, an exotic chewing louse typical of fallow deer, was found on PRNS fallow deer. USDA researchers believe this parasite could transfer from PRNS fallow deer to native elk and black-tailed deer and potentially cause disease in the native cervids (J. Mortensen, USDA, personal communication). *B. tibialis* has been found in a population of symptomatic black-tailed deer in British Columbia during the 1940s (Bildfell et al. 2004) and in large numbers on captive black-tailed deer in Mendocino County, CA, in the 1970s (Westrom et al. 1976). Introduced fallow deer were associated with both of these incidences on black-tailed deer. More recently, *B. tibialis*, evidently originating from local fallow deer, has been found on wild mule deer in poor condition in Washington State (Bildfell et al. 2004; J. Mertins, USDA, personal communication). There is a considerable likelihood of this parasite being responsible for the documented pathology in Canadian and US black-tailed deer (J. Mertins, USDA, personal communication).

Another chewing louse, *Damalinia (Cervicola) forficula*, was found on PRNS axis deer. *D.c. forficula*'s native typical hosts are axis and hog deer and they have been documented in the deer's native range (India, Indochina, Nepal, Pakistan, and Sri Lanka). These lice have never before been identified in North America, and the risks they pose to native deer are unknown.

Finally, *Damalinia (Tricholipeurus) odocoilei*, a chewing louse native typically found on native black-tailed deer, was found on a PRNS fallow deer. Again, the likelihood of this parasite causing disease in either black-tailed, fallow or axis deer is unknown, but it is not usually pathogenic to black-tailed deer.

Ecological Studies

1973–1974: Collection and necropsy of 290 native and non-native deer by California Department of Fish and Game yielded information on food habits. The primary food item for both axis and fallow deer was found to be similar to that of elk and consisted of grass with some use of forbs (Brunetti 1974 and 1975).

1976–1979: Growing concern from ranchers within the park's pastoral zone regarding forage competition between exotic deer and livestock prompted studies on dietary overlap (Elliott 1982; Elliott and Barrett 1985; Wehausen and Elliott 1982). Data were collected in the western and southern portions of the deer ranges but not in the Olema Valley or PRNS-administered GGNRA lands. These studies revealed some dietary overlap between non-native deer and both cows and native black-tailed deer, especially during times of low forage availability. Diets of exotic deer consisted mainly of grasses and forbs and overlapped more with each other than with black-tailed deer except in summer when forbs were an important part of all deer diets. Both exotic and native deer had diets deficient in energy from May through October (Elliott 1982). Elliott and Wehausen found that both axis and fallow deer preferred areas used by livestock (Wehausen and Elliott 1982). Habitat preferences of all three deer species in the pastoral zone were similar, namely, open grassland. Because of insufficient sample size, Elliott could not detect statistically significant effects of non-native deer on black-tailed deer fawn production or survival. He suggested that densities of exotic deer present in 1973 ($\leq$17 deer / sq. km. or 350 of each species) would not negatively affect the density of black-tailed deer (Elliott 1982).

1983: A review of Elliott's 1982 dietary overlap study by Gary Fellers, a U.S. Geological Survey scientist, suggested that exotic deer at levels of 350 for each species could reduce the native black-tailed deer population size by up to 30%. If native deer numbers are strongly influenced by the energy content of their diet, the reduction in their population could be as much as 40% below carrying capacity (Fellers 1983). Recently, further analysis of Elliott's data by Fellers (Fellers 2006) has indicated that the impacts of non-native deer on native black-tailed deer may be more significant than previously thought. At currently estimated population levels for all three species, and during seasons of low forage availability, such as summer, for every 1-2 axis or fallow deer present in the Seashore, one black-tailed deer is lost.

2000: Diets of fallow deer and tule elk were compared in 2000-2001 (Fallon-McKnight 2006). The researchers found that elk and fallow deer in the Limantour area used similar forage species throughout the year. The study concluded (p. 5) that: "Fallow deer, present at Limantour but not at Tomales Point, may impact sympatric elk at the Limantour site in their foraging for *Plantago* spp. (a high energy and high protein forage). Competition for forbs likely remains throughout spring and summer, which is a time that both species are nursing young. This hypothesis requires further testing. Increased grazing pressure on this and other important forage items by fallow deer could potentially deprive Limantour elk of the nutritional benefits of these food resources at a critical time."

2006: USGS researchers studied the impacts of fallow bucks on riparian and woodland soils and vegetation during the breeding season or rut (Fellers and Osbourn 2006). Unlike other cervids, fallow deer form "leks", traditional mating territories revisited yearly and defended by bucks. Researchers sampled two areas within the fallow deer range, the Bear Valley area of Olema Valley, and the Estero trail, and documented a total of 159 leks (see map, Figure 12). The leks were recognizable as areas of bare ground with excavated pits and consisting of compacted, disturbed soils. Leks were up to 32 meters across and included as many as 30 individual pits. The disturbance resembled that of feral pigs, however the soils appeared more compacted than tilled. Over 700 scraped out pits, averaging 2.5 square meters across and up to 0.6 meters deep, were documented in the two areas studied. Vegetation damage included complete removal of understory plants, shredded foliage, damaged tree bark, broken tree branches, exposed roots, and girdling of young trees and saplings. The density of leks in the Estero Trail and Bear Valley area was 28.4 and 78.8 per square kilometer respectively. In Bear Valley, over 1% of the total land area surveyed was impacted with lek damage and riparian areas were disproportionately affected. USGS researchers concluded that fallow deer are having a significant impact on the soils and vegetation in the Seashore. Lekking impacts are shown in Figures 13-16 (note: Figures 13-16 are photographs of fallow deer leks in Olema Valley, taken during the fall and winter of 2005 (Fellers and Osbourn 2006)).

FIGURE 12: MAP OF FALLOW DEER LEK SITES, BEAR VALLEY AREA, POINT REYES NATIONAL SEASHORE (EACH POINT REPRESENTS ONE LEK, COMPRISED OF UP TO 30 EXCAVATED PITS AND AVERAGING 115 SQUARE METERS.) (FELLERS AND OSBOURN, 2006)

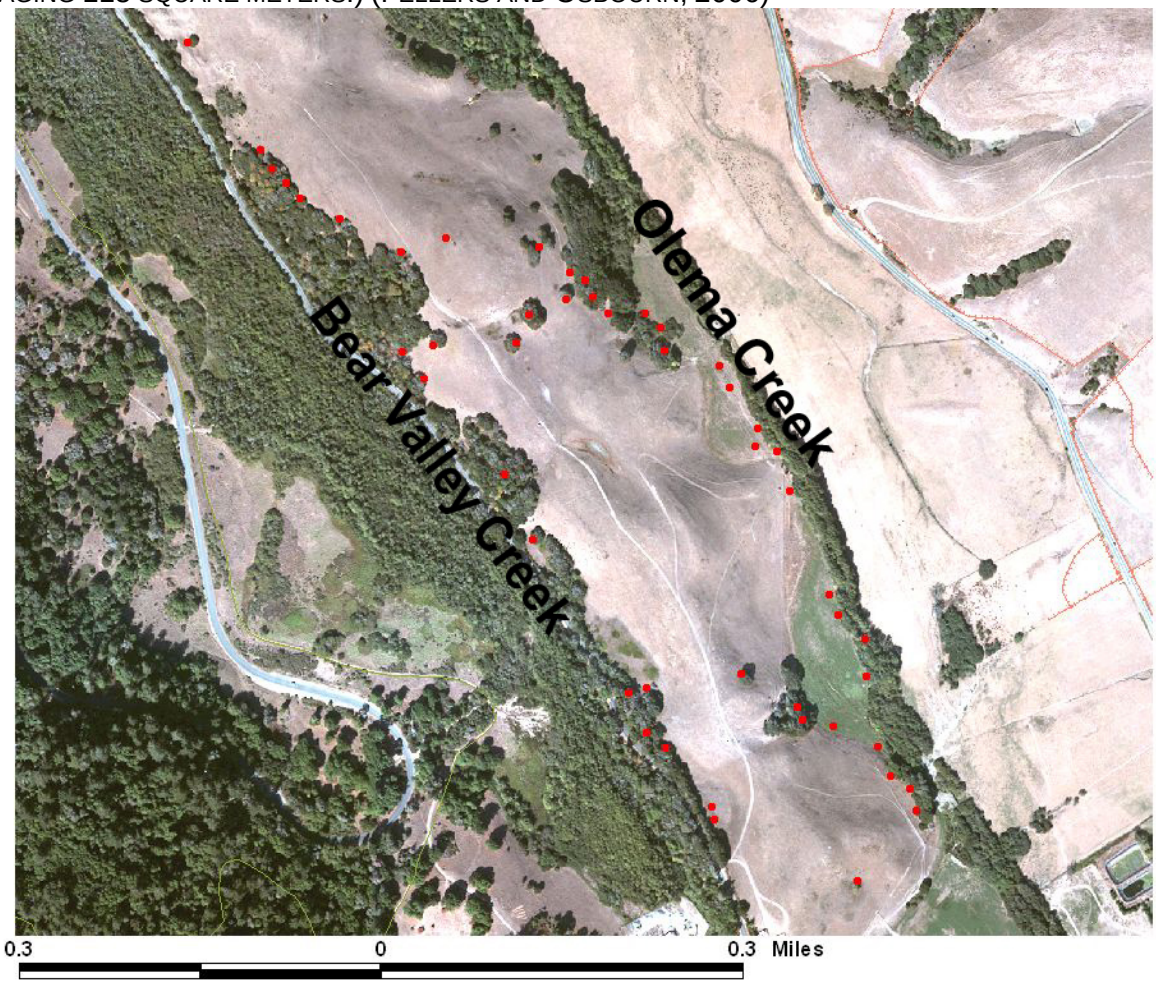


FIGURE 13: BARK DAMAGE (GIRDLING) OF SAPLING DOUGLAS FIR IN A LEK

FIGURE 14: EXCAVATED PIT WITHIN A LEK

FIGURE 15: FALLOW BUCK ON SMALL LEK

FIGURE 16: DISTURBED SOIL AND DENUDED VEGETATION AT LEK SITE, OAK WOODLAND-PASTURE INTERFACE

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Species and Habitats of Management Concern

The U.S. Fish and Wildlife Service (USFWS) and/or the State of California list many of the plant and wildlife species, and habitats present in the project area. The Marine Mammal Protection Act and the Migratory Bird Treaty Act afford additional protection.

Species of Management Concern

The study area supports 47 listed animal species – 14 are federally listed as endangered, 8 as threatened, and 24 as Species of Concern. Among these listed species are the endangered brown pelican (*Pelecanus occidentalis*) and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*). Federally threatened species include Northern spotted owl (*Strix occidentalis caurina*), Western snowy plover (*Charadrius alexandrinus nivosus*), and red-legged frog (*Rana aurora draytoni*). Nineteen federally listed plant species (seven of which also are state listed) and an additional 25 species are listed or proposed for listing by the California Native Plant Society and have been documented in the study area**.** For purposes of this document, all of these species are considered as "Species of Management Concern." The Species of Management Concern that may be affected by implementation of the Non-Native Deer Management Plan are discussed below.

Northern Spotted Owl (*Strix occidentalis caurina*) – Federal Threatened Species

Habitat within the project area supports one of the densest populations of Northern spotted owl in the world. In Marin County, the owls live in second growth Douglas fir (*Pseudotsuga menziesii*), bishop pine (*Pinus muricata*), coast redwood (*Sequoia sempervirens*), mixed conifer-hardwood, and evergreen hardwood forests as well as remnant old-growth stands of coast redwood and Douglas fir. The habitat types for the northern spotted owl are defined as multi-layered, multi-species with >60% total canopy cover for nesting/roosting with large overstory trees, large amounts of down woody debris, presence of trees with defects or signs of decadence in the stand.

Preliminary pellet analyses indicate that spotted owls in Marin forage primarily on dusky-footed woodrats (*Neotoma fuscipes*) as well as other small mammals and forest-dwelling birds (Chow 1998). The Northern Spotted Owl is found throughout Olema Valley and the western and southern wilderness areas of the Seashore.

The Northern spotted owl was federally listed as threatened in 1992 (USFWS 1993). A ¼-mile radius buffer zone must be protected around active nest sites to protect the birds from the impacts of noise. The parks contains approximately 35,000 acres of potential northern spotted owl habitat. Extensive surveys of habitat use, distribution, and abundance have been conducted since 1993 by the NPS and these surveys will continue. A recent census estimated a population of approximately 49 owl activity centers (Chow 1998; Fehring and Adams 2001; NPS 2002b). The park initiated a demographic study of owls in 1998 and has been banding owls annually under permit from the USFWS (Permit # 842449). The overall population trend is unknown, but is believed to be stable because the number of activity centers has been similar among years since 1998 when an inventory of the park was completed.

Western Snowy Plover (*Charadrius alexandrinus nivosus*) – Threatened

Western snowy plovers use the Point Reyes peninsula as both wintering and nesting habitat. Wintering birds occur around Drake's Estero and Abbott's Lagoon, and along Limantour Spit and the Great Beach. During the 1980s nesting took place along the entire Great Beach, Drake's Beach, and at Limantour Spit. In recent years, erosion along the southern portion of the Great Beach has diminished the upper beach area such that the entire beach can be washed by waves. Nesting is occurring on the northern portion of this beach, between the North Beach parking area and Kehoe Beach, which is backed by extensive dunes. Snowy plovers also nest along the western edge of Abbott's Lagoon. Although it had historically been used as nesting habitat by plovers, erosion has affected Limantour Spit and it no nests have been seen since 2000. In 2001 and 2002, all snowy plover nests observed were located on the northern portion of the Great Beach.

Monitoring of nesting snowy plovers in 1986-1989 and 1995-2002 indicates a decline in the number of nesting birds through 1996, followed by a gradual rebound. The Point Reyes Bird Observatory monitored individual nests at all nesting areas during this period. On the Great Beach, where most nesting took place, the number of chicks fledged per egg laid during 1986-89 and 1995 ranged from 1%-7%.

California Red-legged Frog (*Rana aurora draytonii*) – Threatened

The California red-legged frog (*Rana aurora draytonii*) is federally listed as threatened. This subspecies of red-legged frog occurs from sea level to elevations of about 1,500 meters (5,200 feet). It has been extirpated from 70 percent of its former range and now is found primarily in coastal drainages of central California, from Marin County, California, south to northern Baja California, Mexico. Potential threats to

the species include elimination or degradation of habitat from land development and land use activities and habitat invasion by non-native aquatic species.

The California red-legged frog is threatened by human activities, many of which operate synergistically and cumulatively with each other and with natural disturbances (i.e., droughts or floods). Factors associated with declining populations of the frog include degradation and loss of its
habitat through agriculture, urbanization, mining, overgrazing, recreation, timber harvesting, non-native plants, impoundments, water diversions, degraded water quality, use of pesticides, and introduced predators. The reason for decline and degree of threats vary by geographic location.
California red-legged frog populations are threatened by more than one factor in most streams.

PRNS and GGNRA support one of the largest known populations of California red-legged frogs. This frog frequents marshes, slow parts of streams, lakes, stock ponds, and other usually permanent waters. The frog is generally found near water but disperses during rain events and after breeding season to non-breeding habitat adjacent to water bodies. The non-breeding habitat is usually a moist area with some cover such as a willow or blackberry thicket.

The U.S. Geological Survey Biological Resources Division has conducted surveys of aquatic habitats in PRNS and GGNRA since 1993 under the direction of Dr. Gary Fellers. Surveys have been conducted on virtually all sites containing aquatic habitat that could support amphibians. Field data includes information on habitat type (permanent or seasonal, natural or created), water characteristics, (depth, flow, turbidity, etc.), vegetation (emergent, floating, and surrounding the site), disturbance, including current grazing, and the age classes and physical condition of amphibians found.

Field surveys have led to documentation of numerous sites used by the California red-legged frog; sites have been mapped in a geographically related database. Approximately 76 sites are located on ranch lands, with a large proportion located at stock ponds. Several new breeding sites have recently been found along tributaries of Olema Creek. Several large bodies of water, are expected to yield new sites during a planned boat survey, which would allow more thorough coverage than has been attained by foot surveys.

Creation of stock ponds and other small impoundments on ranches over the past 100 years has likely resulted in increased numbers and an expansion in range for red-legged frogs in the PRNS area. Frogs appear to move readily between these ponds during periods when the ground is moist, which is prolonged on the foggy PRNS peninsula. Numerous wet swales, seasonal springs, and ephemeral pools provide dispersed travel and feeding habitats. In GGNRA, riparian habitat along creeks provides corridors for travel along the Olema Valley and its tributaries.

Coho Salmon (*Oncorhynchus kisutch*) – Endangered [state endangered]; Steelhead Trout (*Oncorhynchus mykiss*) – Threatened; and Chinook Salmon (*Oncorhynchus tshawytscha*) – Threatened

Central California coast coho salmon, Central California coast Chinook salmon and Central California steelhead (hereafter referred to as coho, Chinook and steelhead) occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of PRNS and GGNRA. Coho salmon and steelhead trout occur in the Olema, Lagunitas, and Pine Gulch Creek watersheds. Steelhead trout also occur in the Tomales Bay, Drakes Bay, and Bolinas watersheds. Chinook salmon occur in the Lagunitas Creek watershed.

Designated critical habitat for coho in PRNS includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or

above Peter's Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NOAA Fisheries 1996). Although critical habitat has not been established for central California steelhead or Chinook salmon, it is likely to be the same as that for coho in Marin County.

Most historic information on salmonid numbers is anecdotal, while quantified data are lacking. Accounts by local residents of "excellent trout fishing" along Lagunitas and Olema creeks may refer to young steelhead, which are indistinguishable from rainbow trout during the three-year period they typically spend in fresh water. Similarly, early accounts of "salmon runs" may refer to both coho and steelhead, which may not have been distinguished by fishermen. Such anecdotal information suggests that salmonids were abundant in the Lagunitas/Olema Creek drainage before extensive alteration by dam-construction, logging, and channelization. On its 1996 federal listing, the Lagunitas watershed, including Olema Creek, was documented to support 10% of the Central California Coast coho population (Brown et al. 1994; NOAA Fisheries 1996). In their 2001 Status Review, NOAA-Fisheries acknowledged that within the Central California Coast Evolutionarily Significant Unit, the decision to list coho salmon as threatened may have been overly optimistic, concluding that the evolutionary significant unit population was presently endanger of extinction (NMFS 2001). As a result of these and further findings, NOAA-Fisheries completed a rulemaking process in June 28, 2005, which downgraded the coho status (upgraded listing protection) in the evolutionary significant unit to Endangered (Federal Register 2005a).

Adult Chinook salmon have been observed within Lagunitas Creek in increasing numbers since 2000 (MMWD 2003). The increasing frequency of Chinook salmon within Lagunitas Creek may indicate the development of a self-sustaining population, but whether this would persist is unclear (NOAA Fisheries 2004). Because of the proximity of these fish to the southern boundary of the evolutionary significant unit, NOAA Fisheries has treated this watershed population as part of the California Coastal listed population for the purposes of other consultations on the lands of Point Reyes National Seashore and Golden Gate National Recreation Area (NMFS 2004).

Historic and current data on coho and steelhead populations for Lagunitas, Olema, and Pine Gulch Creek watersheds have been gathered as part of the PRNS coho salmon and steelhead trout restoration program and the Marin Municipal Water District monitoring programs. Through the program, the NPS has established a detailed fisheries monitoring program that is carried out through support from the Natural Resource Challenge Inventory and Monitoring Program, as well as monitoring support through California Department of Fish and Game managed grant programs.

For most drainages, monitoring has focused on coho salmon, but includes equivalent information for steelhead trout. Differences between steelhead trout and coho salmon life cycles are pertinent to conservation efforts. While virtually all coho in project area watersheds have an 18-month freshwater life cycle, steelhead juveniles may migrate to the ocean after 18 months or extend freshwater residence for up to three years. Most coho return to spawn after 18 months, but steelhead may spend several years in the ocean before returning to spawn. Additionally, steelhead may make several spawning migrations while all coho spawn once and die. The variable life cycle of steelhead makes population analysis more difficult, but also makes them more resilient to adverse environmental conditions. In general, if the habitat requirements for coho are met, steelhead habitat requirements would also be met.

Chinook salmon typically enter watersheds from October through December. Chinook are typically big river fish, with adults spawning in the mainstem, and are more likely than coho to stray from their natal watershed. Chinook fry emerge from the gravels in early spring and begin growing. They smolt the same year as they emerge and head to estuarine and marine waters in May and June. Their presence in Lagunitas Creek is indicative of offshore productivity and is likely opportunistic.

Salmonid species on the west coast, including coho salmon, steelhead trout, and Chinook salmon have experienced dramatic declines in abundance during the past several decades as a result of human-induced and natural factors. There is no single factor solely responsible for this decline. Factors that threaten these species include water storage, withdrawal, conveyance, and diversions for various purposes. Modification of natural flow regimes have resulted in increased water temperatures, changes in fish community structures, depleted flows necessary for migration, spawning, rearing, flushing of sediments from spawning gravels, gravel recruitment and transport of large woody debris. Natural resource use and extraction leading to habitat modification can have major direct and indirect impacts to salmon populations. Direct and indirect effects of land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation have substantially altered fish habitat quantity and quality. Other factors contributing to the decline of salmonids in the Pacific include commercial fishing, introduction of non-native species and modification of habitat, and long-term operation of production hatcheries.

California Freshwater Shrimp (*Syncaris pacifica*) – Federal Endangered Species

The California freshwater shrimp was listed by the USFWS as endangered (55 FR 43884) in 1988. The shrimp is endemic to 17 coastal streams in Marin, Sonoma, and Napa counties north of San Francisco Bay, California (Fong 1999). This species is the only extant member of the genus (Fong 1999). The shrimp is found in low elevation (less than 116 m), low-gradient (generally less than 1% slope) perennial freshwater streams where banks are structurally diverse with undercut banks, exposed roots, overhanging woody debris, or overhanging vegetation (Fong 1999). As its name would suggest, California freshwater shrimp is believed to occur only in freshwater conditions (less than 0.5 ppt) within streams in the watershed, although it may be able to temporarily tolerate increases in salinity of up 16 to 17 ppt (USFWS 1998).
Threats to existing populations of freshwater shrimp include "introduced fish, deterioration and loss of habitat resulting from water diversion, impoundments, livestock and dairy activities, agricultural activities and developments, flood control activities, gravel mining, timber harvesting, migration barriers, and water pollution" (USFWS 1998). All of these threats have historically occurred along Lagunitas and Olema Creeks.

A study was recently conducted in PRNS and GGNRA to determine the distribution of California freshwater shrimp within streams in the parks, to evaluate the effectiveness of three survey methods for the shrimp, and to provide recommendations for survey techniques for long-term monitoring (LoBianco and Fong 2003). These shrimp reside in the Lagunitas and Olema Watersheds and depend on overhanging vegetation along the creek's banks for habitat. The shade provided by this vegetation is also important to the protection of rare fish species.

The current range of the shrimp within Lagunitas Creek extends from Shafter Bridge in Samuel P. Taylor Park to roughly 1.6 km. below the confluence with Nicasio Creek (Serpa 1991). Shrimp habitat along the main stem of Lagunitas Creek within the Parks is generally protected from agricultural activities occurring within the watershed. Small numbers of shrimp were collected in 1996 and 1997 near the confluence of Olema and Lagunitas creeks (Fong 1999).

California Freshwater shrimp surveys detected small numbers in lower Olema Creek in 2001. The USGS–Biological Resources Division Dixon Field Station is conducting investigations of California freshwater shrimp habitat, survival, and predation within lower Olema and Lagunitas Creeks. This three-year investigation is looking at habitat and flow characteristics supporting the species and has found that native

sculpin are a major predator of the shrimp. Shrimp have not been found in the lower Olema Creek sections during this USGS investigation (LoBianco and Fong 2002).

Myrtle's Silverspot Butterfly (*Speyeria zerene myrtleae*) – Endangered

Myrtle's silverspot butterflies inhabit coastal dune, coastal prairie, and coastal scrub habitats at elevations ranging from sea level to 300 meters, and as far as 5 kilometers inland (Launer et al. 1992). It was federally listed as endangered in 1992. Its historic distribution is believed to have extended from near Fort Ross south to Punta Ano Nuevo. By the 1970s populations south of the Golden Gate were believed to be extinct and populations of the butterfly were believed to exist only within PRNS. Reasons for this decline include urban and agricultural development, changes in natural fire patterns, successional changes in plant communities which have reduced availability of host plants, invasive non-native plants, livestock grazing, over collecting, and other human impacts.

Following discovery of a population near the Estero de San Antonio in the early 1990s, field surveys were conducted by the Center for Conservation Biology at Stanford University. Two additional, apparently separate, populations in PRNS were located and fieldwork was done to estimate population sizes. One population, centered on North Beach, extended from Abbotts Lagoon to South Beach and east to Drakes Estero and Drakes Beach. The highest numbers were found along the dune-scrub interface in the back dune area of the central peninsula on F and G ranches and the AT&T property, and on the bluffs on either side of the Drakes Beach visitor center. The population was estimated to number in the low thousands in 1993. Survey work in 1998 put the population estimate at 50-200 individuals, with no silverspots being found in portions of the 1993 range. The other population was found on the Tule Elk Reserve, with small numbers on the adjacent J Ranch. In 1993, the number of individuals in this population was estimated to be in the mid-hundreds. The 1997 survey of this northern Point Reyes population gave a population estimate of 250-500 (Launer et al. 1998).

Silverspot numbers in the area outside of parklands around the Estero de San Antonio were estimated at 2,000-5,000 individuals in 1991. Other nearby areas with potentially suitable habitat was not surveyed. Together with those found at PRNS, estimated numbers for the three known populations of the species total less than 10,000 individuals (USFWS 1998).

Known Myrtle's silverspot nectar plants include curly-leaved monardella (*Monardella undulata*), yellow sand verbena (*Abronia latifolia*), seaside daisy (*Erigeron glaucus*), bull thistle *(Cirsium vulgare*), gum plant (*Grindelia* spp.), and mule ears (*Wyethia* spp.).

Populations of Speyeria butterflies experience large population fluctuations, and population increases of tenfold or more in a single year has been observed. In 1994/95, California's central coast experienced a very wet winter that reduced numbers of many late-spring and summer-flying butterflies (silverspots are among the latter). Another wet winter occurred in 1997-98, which may have resulted in the low numbers for the central Point Reyes population observed in summer, 1998.

Due to the lack of historic data previous to the 1990s, it is not known if the silverspot has declined at Point Reyes.

Habitats of Management Concern

Numerous habitat types are afforded protection under various laws and regulations within the project area. Through the 1997 Magnesun-Stevens Act, the National Marine Fisheries Service (NMFS) has designated Essential Fish Habitat supporting a variety of species. Within the project area, the Essential Fish Habitat designation applies to all streams within NPS lands. The USFWS has designated critical

habitat for the protection of the California red-legged frog, which includes nearly all of the land within the project area.

Human Health and Safety

In a national park, wild animals can potentially cause disease transmission, vehicular accidents, or bodily injury to visitors or staff that come in direct contact with them. These risks are present whether or not wildlife is actively managed or not. Existing deer management activities are confined to disease research and population studies, occasionally with the use of aircraft.

Deer management proposals analyzed in this document include the use of firearms, aircraft, and chemical sterilant drugs, all of which can affect health and safety of visitors and staff. Existing regulations including the NPS *Management Policies* 2001 and several Director's Orders address the above activities (see NPS *Management Policies* 2001, Policies and Regulations, sec. 4.5.6) and would be implemented to ensure human health and safety during project implementation. Among other things, these policies and regulations contain specific language regarding how to ensure public health and safety within areas of NPS jurisdiction and specify when appropriate certifications related to it are required (e.g., use of firearms and aviation).

Visitor Experience

The project area is unique not only in its assemblage of natural and cultural features, but also in its proximity to a major urban population. This juxtaposition makes the PRNS resources and recreational opportunities readily accessible to a large number of people, and enhances the importance of the special qualities for which it was set aside. PRNS is one of the 30 most visited parks in the National Park System and is visited by over 2.3 million people annually. Seventy percent of these visitors came from the 9 San Francisco Bay Area counties, with the remaining 30% traveling from across the state, the country, and around the world (Sonoma State University 1998). The park is a destination park for national and international visitors and a regularly visited resource for the 5 million residents of the 9 counties of the greater San Francisco Bay Area. In 2002, over 700,000 visitors went to the 3 park visitor centers (PRNS visitor use data 2002). Yearly, over 70,000 visitors have extended contacts with park interpretive staff through ranger-led programs.

Visitor facilities and recreational opportunities include 4 backcountry campgrounds, 147 miles of trails, numerous beaches, 3 visitor centers, and 2 environmental education centers. Activities include hiking, water sports, horseback riding, fishing, camping, wildlife viewing, and interpretive opportunities. The highest visitation occurs during the months of July – October and is primarily on weekends (National Park Service, Monthly Public Use Reports). A survey conducted in 2005 indicated that 100% of visitors were "satisfied overall with appropriate facilities, services, and recreational opportunities" (University of Idaho Cooperative Parks Studies Unit for the National Park Service, Department of the Interior, 2005).

Hiking is primarily a day-use activity. Approximately 50 trails are designated throughout the Seashore, and they encompass a range of habitat types from wooded mountains to sandy beaches. Overnight accommodation is available at hike-in campgrounds or local hotels and inns. Dozens of visitors bring horses to ride on designated horse trails, and hundreds rent horses every week from commercial stables.

Water sports include kayaking, canoeing, boating, and swimming. The majority of paddle crafts use Tomales Bay as it provides protection from the Pacific waves and surf, while power boaters more freely use the ocean. Surfers have been known to use the waters off the Seashore, but most surf south of the Seashore closer to population centers with better beach access.

Nature study and wildlife viewing, including the viewing of exotic deer species, are important activities at Point Reyes. Park visitors have been observing wildlife in the Seashore since its inception. Visitors commonly comment to NPS staff on the park deer, including fallow and axis deer. Most often, the comments relate to the white color variants of the fallow deer. Typically, the average park visitor does not distinguish fallow deer from native black-tailed deer (John Dell'Osso, NPS, personal communication). Visitors often confuse fallow deer with "elk," "moose," and "albino deer." Winter whale migrations off the coast bring many visitors and commercial whale watching operations into the area. Sea lions, tule elk, shorebirds, and spring wildflowers all attract their share of observers.

The NPS gathers standardized annual surveys for each park unit to determine the percent of visitor satisfaction based on park facilities, visitor services, and recreational opportunities. Sonoma State University conducted visitor surveys in 1997 and 1998 (Sonoma State University 1998). Results showed that park visitors spend an average of 2-6 hours at the seashore in a variety of seasonal activities. Those activities range from whale watching and kayaking to hiking and bird watching.

In 2003, the Point Reyes National Seashore Association, a non-profit organization, funded a telephone survey of 418 residents within Marin, Sonoma, San Francisco, Alameda, and Contra Costa counties (Responsive Management 2003). Respondents were asked questions on general management, recreation, and the founding principles for the Seashore. They were also given a brief overview of the history of non-native deer in the park and asked to respond to a number of questions concerning deer management. Sampling error was $\pm$ 4.8 percentage points. Survey results, as they relate to management of non-native deer, are as follows:

Almost all respondents (97%) felt that preserving native ecosystems was a very or somewhat important reason to have a National Park.

Most respondents (77%) said they would support reducing numbers of non-native deer if they were determined to be causing damage to native wildlife, vegetation, or other natural resources.

53% of respondents opposed (41% strongly and 12% moderately) the use of lethal methods to reduce numbers of non-native deer while 35% supported (14% strongly and 21% moderately) lethal control. Respondents who had not visited the park were slightly more likely than visitors to oppose lethal control.

65% of respondents supported (37% strongly and 28% moderately) the use of "an injection that would cause permanent sterilization and not allow them to produce any further offspring." Twenty percent of respondents opposed sterilization (14% strongly and 6% moderately). Respondents who had visited the Seashore were more likely to support sterilization than non-visitors.

61% of respondents who had visited PRNS and 87% of non-visitors felt they knew nothing about the non-native deer in the park before the survey.

As park staff continues to educate and inform visitors of native versus non-native species issues and the impacts that non-native species can cause, park visitors would have greater appreciation for preserving native ecosystems. A pilot survey conducted by Sonoma State University in 2002 (Sonoma State University 2003) showed respondents didn't think the park should ignore detrimental impacts of non-native species to native species. Restoration of native ecosystems in the Seashore would provide high quality visitor experiences to those members of the public seeking a view of what coastal California fauna once was.

Social Values

Social values, a part of the visitor experience, include general public attitudes toward wildlife management and issues of humaneness as it relates to proposed actions (lethal removal and contraception). The interpretation of what constitutes harm or suffering to an animal varies from person to person, with different people perceiving the humaneness of any given action differently (USDA 1997). Kellert (1976) identified a number of distinct attitudes toward wildlife including naturalistic, ecological, humanistic, moralistic, scientific, aesthetic, utilitarian, dominionistic, and negativistic (see Table 5 for definitions). As with wilderness values, while people typically possess more than one view of animals, most people hold a predominant view.

TABLE 5: PERCEPTIONS OF ANIMALS IN AMERICAN SOCIETY

Attitude	Key Identifying Terms	Highly Correlated With	Most Antagonistic Toward
Naturalistic	Wildlife exposure, contact with nature	Ecologistic, humanistic	Negativistic
Ecological	Ecosystem, species interdependence	Naturalistic, scientific	Negativistic
Humanistic	Pets, love for animals	Moralistic	Negativistic
Moralistic	Ethical concern for animal welfare	Humanistic	Utilitarian, dominionistic, scientific, aesthetic, negativistic
Scientific	Curiosity, study, knowledge	Ecologistic	None
Aesthetic	Artistic character and display	Naturalistic	Negativistic
Utilitarian	Practicality, usefulness	Dominionistic	Moralistic
Dominionistic	Mastery, superiority	Utilitarian, negativistic	Moralistic
Negativistic	Avoidance, dislike, indifference, fear	Dominionistic, utilitarian	Moralistic, humanistic, naturalistic

SOURCE: S. Kellert (1976)

At the Seashore and other park units, objections have been raised by some individuals and interest groups to certain of the management techniques proposed by NPS units for management of non-native wildlife, notably lethal control (Sellars 1997). A number of animal rights and welfare organizations and private individuals also raised a range of issues during public scoping for this document (see Chapter 5, Consultation and Coordination). These objections were presumably raised on moralistic or humanistic grounds, e.g., that inflicting of pain and/or death to animals is unethical.

Animal welfare advocates promote the minimization of pain and suffering to animals and their organizations promote the well–being and quality of life of individual animals, irrespective of the animals' role in an ecosystem. In contrast to the animal welfare movement, the animal rights movement is premised on the equality of humans and animals. The proposed equality exists because of the capacity for suffering in both humans and non-human animals. Singer states: "No matter what the nature of the being, the principle of equality requires that its suffering be counted equally with the like suffering – in so far as rough comparisons can be made – of any other being" (Regan and Singer 1989). Because of the deemed equivalent capacity for suffering, the killing of animals, whether for meat production or for sport, as well as the use of animals in scientific research, are considered as offensive as such practices would be if they were conducted on humans. The moral focus of the animal rights viewpoint is, as with animal welfare, the individual animal. As Warren states: "the needs and interests of individual beings (are) the ultimate basis for conclusions about right and wrong" (Warren 1992). Regan describes the animal rights view of wildlife management as: "In general the (animal) rights view's position is to let wildlife be. Wildlife management

ought to be designed to protect wild animals against hunters, trappers, and other moral agents (human beings)" (Regan 1983).

Other visitors to the Seashore are perhaps more naturalistic or aesthetic in their attitudes about non-native deer. As noted in other sections of the document, as visitors are educated on the natural ecosystem of the Seashore and the impact fallow and axis deer have on it, their attitudes sometimes shift more to the ecological described on Table 5 above.

There are no specific federal directives for NPS in regards to animal welfare or animal rights. NPS management of wildlife, as described in the NPS *Management Policies* 2001, is based on a biocentric ethic and not on single animals. In addition, NEPA does not consider animal rights or animal welfare to be an environmental issue or resource element. However, animal welfare issues were raised during public scoping. As an ethic held by a certain segment of the public, belief in animal rights and animal welfare can be considered part of the human environment and are therefore discussed as a part of the visitor experience.

In addition, as a matter of general policy in all wildlife management activities, Seashore managers always endeavor to minimize animal suffering, eliminate unnecessary pain to every extent possible and comply with the recommendations of the American Veterinary Medical Association (see Actions Common to All Alternatives). For a detailed description of these recommendations, consult the American Veterinary Medical Association website: www.avma.org/resources/euthanasia.pdf.

Wilderness

The Wilderness Act

The Wilderness Act, passed on September 3, 1964, "provides a degree of protection to the resources of the National Park System that the NPS Organic Act does not." The House Report accompanying the act, which helps to clarify congressional intent in passing legislation, states that its purpose is to establish a National Wilderness Preservation System made up of designated wilderness areas "because of the undeveloped character of their lands and the need to protect and manage them in order to preserve, as far as possible, the natural conditions that now prevail" (House Report No. 1538, 88th Congress, 2nd session, July 2, 1964).

The Wilderness Act includes a lengthy definition of wilderness, including phrases such as:

- An area where earth and its community of life are untrammeled by man
- An area where man himself is a visitor who does not remain
- An area of underdeveloped land retaining its primeval character and influence
- An area protected and managed to preserve its natural conditions
- An area that generally appears to have been affected primarily by the forces of nature
- An area with the imprint of man's work substantially unnoticeable
- An area with outstanding opportunities for solitude or a primitive and unconfined type of recreation

What the Wilderness Act apparently did not anticipate was a condition where lands were either not in a natural state when they were designated as wilderness or where large-scale changes in environmental conditions (invasion of exotic species, acid rainfall, etc.) occurred such that the natural state was altered. When either of these conditions occur, intervention in the form of "intentional control or manipulation" may be required. Although this is perhaps "trammeling" in that human, rather than "natural" activities are

conducted, it also returns the wilderness to an "untrammeled" or "natural" pre-impact state in the long-term.

Wilderness Character

NPS policies indicate that environmental impact statements should evaluate wilderness character and values, including the primeval untrammeled character and influence of the wilderness; the preservation of natural conditions (including the lack of man-made noise); and assurances that there would be outstanding opportunities for solitude and the public would be provided with a primitive and unconfined type of recreational experience.

Wilderness character has multiple components, including naturalness, wildness, the lack of man-made noise, and conditions for a specific kind of visitor experience where people are able to find solitude, a primitive and unconfining environment, and an escape from the modern day world. For the most part, visitors to the backcountry in PRNS can usually expect few encounters with other visitors and natural quiet.

Like most wilderness areas in the National Wilderness Preservation System, the Point Reyes National Seashore Wilderness was not pristine when it was designated due to the history of Euro-American land use practices described in the Park Management Zoning section of this chapter. These practices include agricultural use, introduction of non-native ungulates, and fire suppression over the past century. As a result, "unnatural" conditions exist today. Because scientific evidence indicates adverse ecological impacts are occurring, these conditions would continue to reduce the park's biological productivity without human intervention. In other words, the requirement of the Act to "preserve natural conditions" is unattainable without overt management.

Wilderness Values

People who use wilderness, as well as those that do not, all have opinions about why it is valuable. These perceptions about the benefits of wilderness are referred to as "wilderness values" and change from person to person and from wilderness to wilderness. No surveys of wilderness users at PRNS have been conducted, therefore it is unknown what particular values visitors ascribe to Seashore wilderness. Instead, this section describes values users have placed on wilderness in general.

The values applied to wilderness are wide-ranging, and have been grouped into biocentric and anthropocentric categories. The biocentric includes the existence of natural, ecologic conditions. These include protecting natural ecological processes, wildlife habitat, habitat for rare and endangered or unique plants and animals, protecting watersheds and water quality, and protecting air quality.

Anthropocentric values include experiential benefits from recreating in wilderness, educational values, generating tourism revenue for adjacent or nearby gateway communities, aesthetic and spiritual values, the knowledge that wilderness areas exist and would exist in the future, and intrinsic or symbolic values.
Agencies, academics, recreational users and the general public may also hold strong and varying opinions about whether intervention in a wilderness to restore its naturalness is warranted or advisable. The literature suggests that most people typically hold more than one attitude towards an issue and react differently in different situations. Nonetheless, it is possible to identify in most people predominant characteristics of a primary attitude toward an issue. For example, ranchers tend to have a utilitarian attitude towards the environment (value measured in terms of usefulness), while conservationists may have an ecological or preservationist view (Kellert 1976).

Park Operations

Currently the park has about 90 permanent, 23 term and 47 temporary employees working on a variety of projects and programs. This represents about 116 FTE (full time equivalents). During the peak visitation (summer) months, the park staff increases to about 160 employees, including Youth Conservation Corps enrollees. The year-round work force is supplemented by 20,000 hours of Volunteers-in-Parks service, three Student Conservation Assistants, and AmeriCorps volunteer work groups and special project and program funds distributed by the NPS regional and Washington offices.

Financial resources available to achieve the park's annual goals include a base-operating budget of approximately $5.6 million. In addition, the park receives supplemental support for fire operations, cyclic maintenance, special natural resource projects, and repair and rehabilitation of structures.

The park expects to receive fees revenues and special national park funding of about $1.6 million in a one-time funding round this year for cyclic maintenance of historic structures and other natural resource projects. The park would also receive about $625,000 in fee revenues for other maintenance projects and operation of the whale shuttle system and campground reservation system. As part of the San Francisco Bay Network, the National Seashore would have access to approximately $810,000 for natural resource challenge inventory and monitoring funds. The park receives approximately $1,000,000 in FirePro and Wildland Interface funding for hazardous fuel reduction and fire prevention activities.

The operating budget for the PRNS deer management program in FY 2002 was $113,000. An additional $100,000 was made available through fee funds and grants earmarked for specific management projects. Staffing for the deer management program is 3.0 FTE's.

Until 1994, the Seashore maintained the populations of the two non-native deer species under guidance received by the Point Reyes National Seashore and Golden Gate National Recreation Area Citizen's Advisory Commission. This recommendation called for controlling the herds of axis and fallow deer at a population level of 350 animals each through direct ranger culling. A research program of collection and necropsy to study animal nutrition, health, parasite loads and disease was conducted between 1976 and 1979. Beginning in 1980, the Seashore implemented a management program to control population size at the stipulated herd size. Between 1984 and 1994, 1412 fallow and axis deer were removed at a total cost of $30,200 (including personnel costs, ammunition costs and vehicle mileage) at an average cost of $21.39 per animal (NPS unpublished data ((h)). These costs do not include administrative, training, interpretive or equipment costs. An estimate of all costs associated with this reduction program average $20,736 per year (Wates 2003). Since the end of the direct management program in 1994, the axis deer population has rebounded to 1973 levels. Fallow deer numbers have grown considerably, and now exceed any previously recorded numbers (NPS 2002a).

PRNS (including GGNRA North District) maintains the necessary infrastructure to support an annual park visitation of 2.25 million people, provide offices, support structures and provide limited housing for the permanent and seasonal park staff. Park structures include:

- 3 visitor centers
- 2 environmental education centers
- 30 restroom complexes
- 4 backcountry campgrounds
- 17 water systems
- 147 miles of trails
- Over 100 miles of roads
- Over 100 public and administrative structures

- 27 sewage treatment systems

PRNS also manages and protects park cultural resources including:

- 297 historic structures
- 127 recorded archaeological sites
- 11 identified cultural landscapes
- 498,000 museum objects

Regional Economy (Socioeconomics)

Marin County has a $450 million annual tourist industry. It is estimated that PRNS contributes over $150 million to the regional economy with visitor expenditures on dining, fuel, gifts, groceries and lodging (National Parks Conservation Association 2002). According to a visitor survey conducted by Sonoma State University (1998), 74% of visitors travel to the Seashore as their main destination, 30% of visitors remain in the park overnight, and 40% of visitation comes from Marin, Sonoma, and San Francisco Counties (16.5% comes from outside of California).

Point Reyes National Seashore received 2.3 million visitors in 2001. The average visitor party spent $95 per party per night in the local area. This spending from visitors from outside the local region generated $83.6 million in sales for local businesses, yielding $39.3 million in personal income and supporting 2,000 jobs (NPCA 2002). Each dollar of tourism spending yielded another $0.63 in sales through the circulation of spending within the local economy. Including these secondary effects, the total economic impact was $113 million in sales, $42 million in wages and salaries, and 1,800 jobs (Michigan State University 2001).

The 165,000 acres of Marin County farmland produced olives, hay and silage, wine grapes, and organic produce earning in excess of $4 million in 2001 (Marin Agricultural Land Trust data 2003). Dairy and beef cattle produced about $40 million. Twenty percent of the Bay Area's milk supply is produced in Marin dairy farms. Countywide, two hundred farms and ranches employ 1,400 people.

Commercial Operations within the Pastoral (Agricultural) Zone

Commercial, agricultural, and aquaculture production occurs within the Seashore, including the following:

- 7 dairies
- 19 beef cattle ranches
- Silage production on approximately 1,000 acres of land
- Oyster production in Drakes Estero
- Water supply to Bolinas Community

PRNS contains approximately 18,900 acres currently used for traditional agriculture, including the 17,040-acre Pastoral Zone and other lands on which ranching takes place. PRNS-administered GGNRA lands include approximately 10,000 acres currently in ranching use. The legislation establishing both PRNS and GGNRA included provisions for continuing the historic ranching uses on some of the lands acquired for these parks. As agricultural lands were purchased, sellers were allowed to continue dairying or beef ranching under one of two arrangements. They could retain a Reservation of Possession, under which they would forego a portion of the purchase amount in exchange for the right to continue ranching activities for up to 25 years. Alternately, they could sell outright and enter into Special Use Permit agreements of up to five years with NPS. Some sellers retained a Reservation of Possession on part of

their land, and entered into Special Use Permit agreements for the rest, while others have entered into more than one Special Use Permit agreement with NPS.

The 24 ranchers currently operating within the project area hold 11 Reservations of Possession and 30 Special Use Permits. Most of the Reservations of Possession expire in the next decade. It has been the policy of PRNS in the past to allow ranchers whose Reservation of Possession terms expire to continue ranching operations under Special Use Permits. Together these permittees and Reservation of Possession holders support approximately 6,013 cattle on a year-round basis.

Current impacts to those ranchers who see non-native deer year-round include:

- Fence repair costs. Ranchers report that non-native deer damage fences by passing under them repeatedly in large numbers. Bucks have also been reported to break fence wires with their antlers.

- Cost of lost pasture forage. A number of ranchers indicated that loss of pasture forage, through consumption by non-native deer, was causing a major reduction in the number of cattle that could be supported on leased pastures. It is estimated that there are about 250 axis and 860 fallow deer in the park. Their total food intake on the ranches is unknown but the average deer consumes approximately 3% of its body weight in forage per day, or between 3 and 6 lb. per adult doe or buck.

- Cost of lost supplemental feed put out for livestock. One rancher indicated that non-native deer, at a substantial cost to the rancher, were eating supplemental feed put out for livestock during the dry summer season.

- Cost of reseeding pastures. One rancher indicated that in recent years, non-native deer have overgrazed fallow (ungrazed) fields. These pastures are seasonally removed from livestock grazing by the rancher in order to allow natural grass reseeding. Because of heavy grazing of the new seed heads by non-native deer, purchase of seed was required.

- Veterinary costs. One rancher attributed an increase in "moon blindness" in ranch horses to increased densities of fallow deer in recent years. Ranch horses also tested positive for exposure to leptospirosis, a bacterial disease, which can cause ophthalmic disease and abortions in livestock. The disease can be carried by a number of mammalian species, including rodents, skunks, raccoons and deer. Two of 16 non-native deer culled and necropsied for disease testing in 2000 showed serological evidence of exposure to leptospirosis (NPS unpublished data (g)). On the advice of a veterinarian, the rancher has subsequently vaccinated all the ranch livestock for the disease. Animals affected by the opthalmic form of the disease ("moon blindness") were treated by a veterinarian.

The following table lists approximate numbers of Seashore ranches in which various impacts, attributable to non-native deer in the past 3 years, have been observed. Cost estimates are approximate and encompass only those directly attributed to non-native deer by the ranchers themselves. Information in this table was collected through conversations with ranchers in April, 2003.

TABLE 6: CURRENT ECONOMIC COSTS OF NON-NATIVE DEER TO SEASHORE RANCHERS

Cost Category	Number of Ranches Reporting	Approximate Cost per Rancher (2002)
1. Increased fence repairs	4	$500 - $1,000 per year
2. Loss of pasture forage to non-native deer	4	unknown
3. Loss of supplemental feed (hay or grain) to non-native deer	1	unknown
4. Required reseeding of pastures due to non-native deer	1	$9,000 per year
5. Increased veterinary costs	1	$1,200 in 2001

Cattle ranchers outside the park boundaries have also experienced damages from similar impacts caused by non-native deer estimated at approximately $3,500-4,000 per year. An organic produce farmer outside NPS boundaries has experienced noticeable depredation of planted vegetables during the fall from fallow deer migrating out of the Seashore. In addition, damage to ornamental plants/gardens in neighboring private gardens has also been attributed to fallow deer.